SCIENCE

2 January 1959

Volume 129, Number 3340

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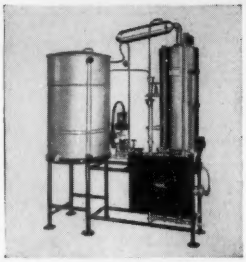

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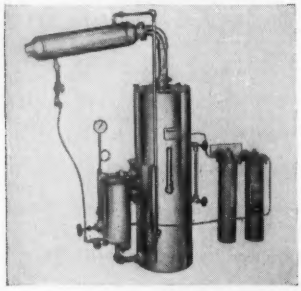

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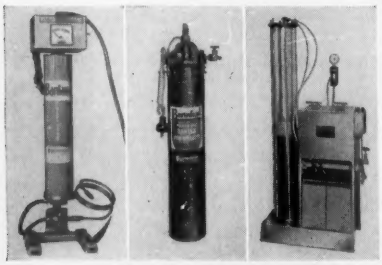

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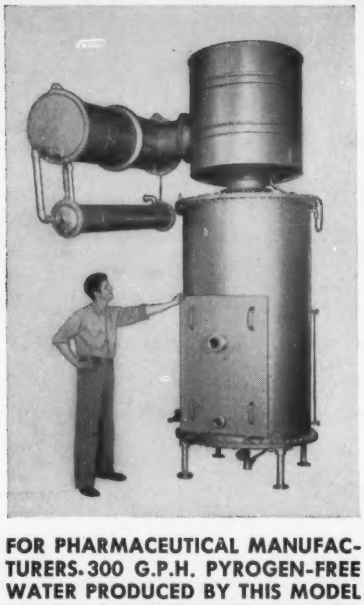

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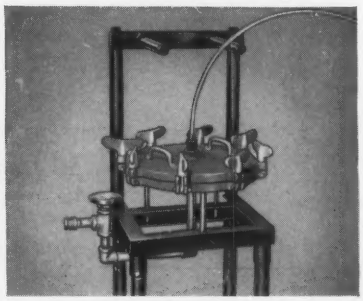

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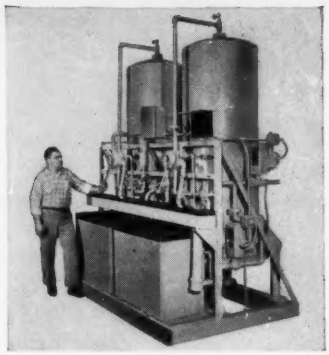

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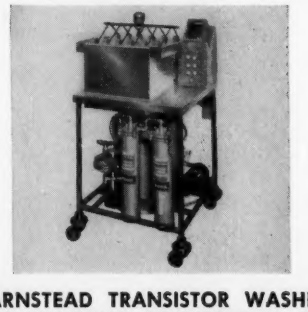

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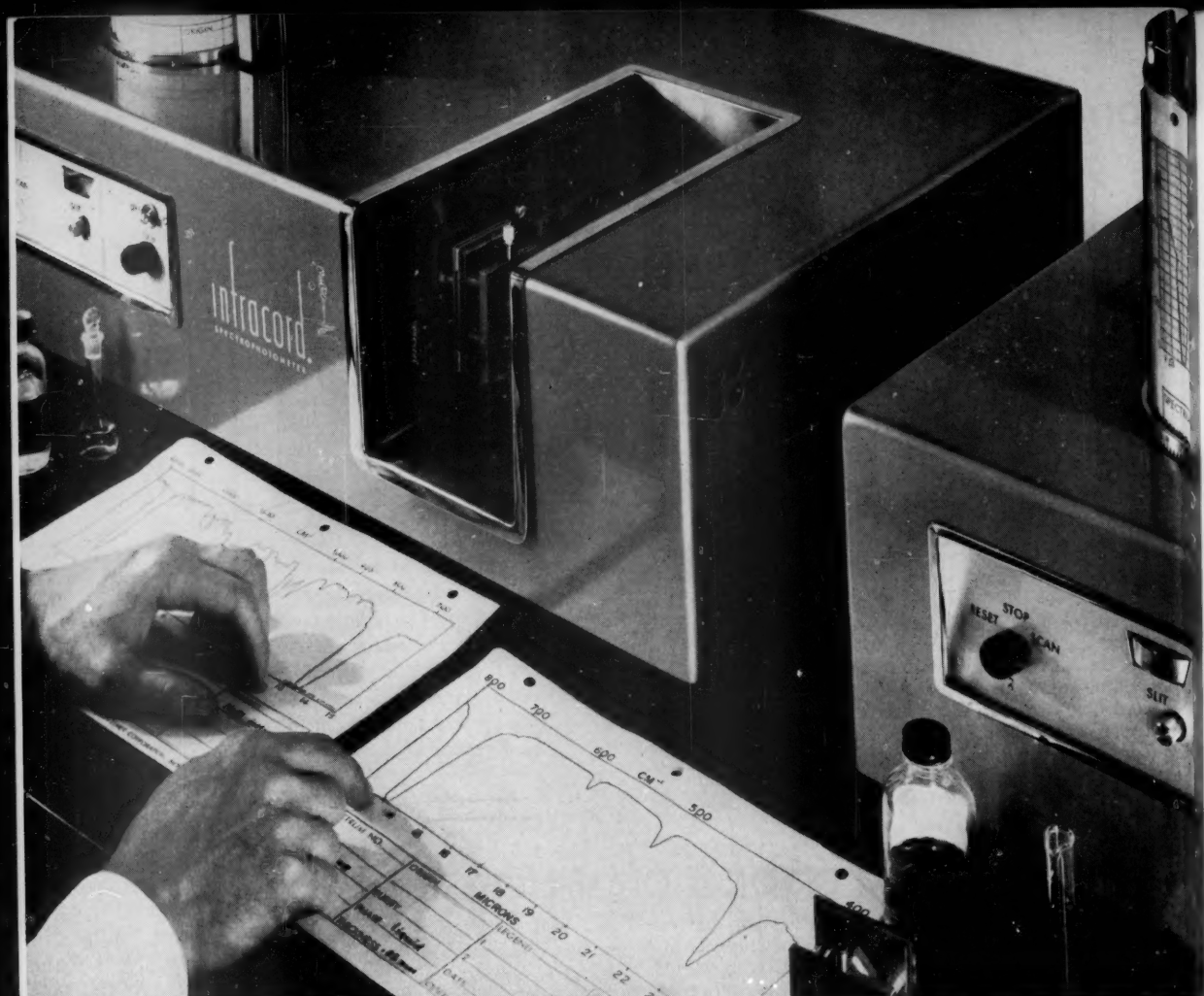

Spectra of ortho-xylene, made on an NaCl Model 137 (left) and a KBr Model 137 (right), show extension of infrared analytical ability with new low-cost instrum

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SCIENCE

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Prospect and Retrospect

The new year is a good time to take a look at the past and to lay plans for the future. A year ago in this space we described our policies for the combined *Science* and *The Scientific Monthly*. At that time we expressed the hope that the number of papers in the "Articles" section (as opposed to those in the "Reports" section) would be increased and that more of the articles would be of the relatively nontechnical sort that was characteristic of the *Monthly*. It was our hope that the combined journal would be more comprehensive, interesting, and useful than either journal by itself.

Here are some of the changes that have taken place. The "Letters" section has flourished during the year and has, as we hoped when it was started in 1956, become a vigorous forum for the exchange of ideas and for debate about scientific matters of public concern; the addition of abstracts to the reports has met with general approval, both from readers and from professional abstracting journals; the regular use of subtitles for articles has given the reader a better clue to their contents; and the freer use of illustrations has added interest and appeal to the articles.

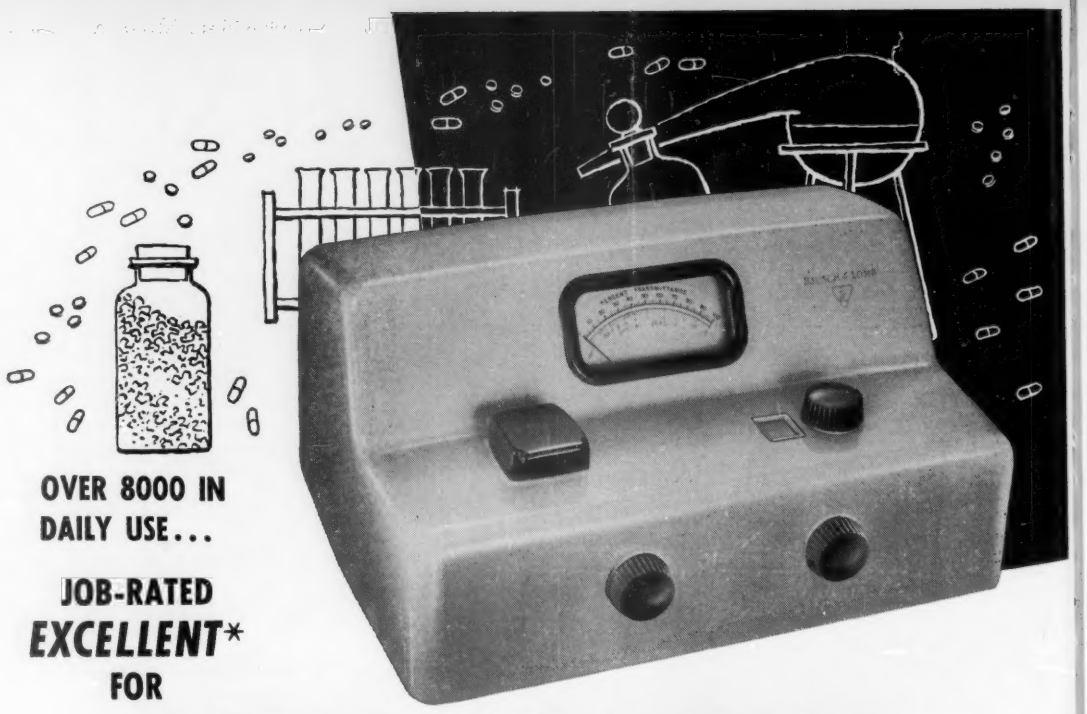
But these are all minor changes. The most important changes are in the distribution and numbers of the articles. The percentage distribution of articles in major fields was as follows: public affairs, 23 percent; physical sciences, 23 percent; biology, 21 percent; social sciences, 12 percent; history and philosophy of science, 6 percent; and, in a special category that reflects the interests of our day, radiation science (radiocarbon dating, radiobiology, fallout), 15 percent.

A comparison of *Science* in 1958 to *Science* in 1957 shows some of the quantitative changes that have taken place. The total number of articles published rose from 96 in 1957 to 133 in 1958; the number of books reviewed rose from 330 to 435; the number of reports increased only slightly, from 441 to 451.

The number of articles by major fields gives a more detailed view. In public affairs (including legislation, conservation, matters of professional interest, and education) the number of articles rose from 21 in 1957 to 30 in 1958; in physical sciences, from 21 to 31; in biological sciences (including medicine and biochemistry) the number decreased from 29 to 28; in the social sciences (including psychology, archeology, economics, and sociology) the number increased from 8 to 16; in history and philosophy of science, from 4 to 8; and in radiation science, from 13 to 20.

In general it is our impression that those of our readers who formerly took *Science* think the combination a success, but many of those who formerly took the *Monthly* do not. This is understandable, for the *Monthly* readers faced an abrupt change. Instead of getting a monthly magazine which contained a high proportion of nontechnical articles, they began getting a weekly magazine which contained both nontechnical and highly specialized articles as well as some features not included in the *Monthly*: editorials, obituary articles, news of science and government, and technical reports. In the minds of some readers, the "bad" (technical articles and reports) outweighed and perhaps obscured the "good" (nontechnical articles). At any rate, a comparison is in order. In 1957 the *Monthly* carried 57 nontechnical and 7 technical articles; in 1958 *Science* carried 85 nontechnical and 48 technical articles. So far as book reviews are concerned, the difference is more marked: the *Monthly* carried 140 reviews in 1957; *Science*, in 1958, carried 435.

What of the future? We expect that *Science* will continue to be a journal for the announcement of important scientific discoveries. In addition, we hope to publish a larger proportion of readable, nontechnical, but authoritative articles, and we plan to illustrate them more fully. We hope to achieve a better balance in the different scientific fields, both in the articles and the reports. And, in this third year of the earth satellites, we intend to give more thorough and up-to-date coverage of the events of scientific interest, both in our news and in our editorial columns.—G.DuS.



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Fifty Years of Medical Genetics

The union of biochemistry and genetics offers a rational approach to diagnosis, prevention, and therapy.

Laurence H. Snyder

Fifty years ago, in 1908, Sir Archibald E. Garrod presented in England a most remarkable set of the Croonian lectures (*1*), setting forth a new concept of human disease, which he called "inborn errors of metabolism." Garrod was far ahead of his time in this concept, and it took many years for geneticists to appreciate the full significance of his contribution. The rapid and widespread development of medical genetics at the present time owes its inception to the recently renewed interest of human geneticists in Garrod's demonstration that, through mutation, the dysfunction of a gene-controlled enzyme necessary for normal metabolism is a basic mechanism in the production of genetic disease.

The term "genetic disease" is used in this paper to apply broadly to any deviation from the usual or normal condition, for which a genetic basis can be established. I shall attempt to show that there are reasons for believing that genetics is involved in one way or another in the development of all disease.

Garrod illustrated his concepts with his own basic studies of four human anomalies: albinism, alcaptonuria, cystinuria, and pentosuria. Today, both in experimental organisms and in man himself, the identification of many enzyme dysfunctions with mutant genes has reached a high point of development. On this 50th anniversary of Garrod's basic contribution, it is with deep appreciation of his foresight and ability that I offer a survey and critique of some of the advances in medical genetics that we have been able to build on the foundation of his fundamental concepts. Through the expansion of these concepts, genetics and biochemistry are rapidly becoming facets of one and the same science, and the resulting mosaic is playing an indispensable role in the progress of medicine.

The reawakening of the interest of medical geneticists in the biochemical backgrounds of genetic diseases apparently had to await the occurrence of a number of other developments (*2*). Three main events brought into sharp focus the steps intervening between the presence of a gene in the cell and the appearance of a trait or disease in the individual, and thus led to a renewed interest in Garrod's suggestions. The first of these events was the firm establishment of the concept that all metabolism proceeds through series of small sequential steps, each step catalyzed by an enzyme. The second was the demonstration (*3*) that increase in radiation level can increase the mutation rate. The third event was the realization (*4*) that with the aid of radiation-induced mutations the biochemical activities of genes can be definitively studied in microorganisms which are peculiarly suited both to genetic and biochemical investigation. The researches undertaken all over the world along these lines have brilliantly demonstrated the facts that many enzyme dysfunctions are indeed referable to specific mutant genes and that it is reasonable to presume that the production of normal enzymes is dependent on the activity of the normal unmutated alleles of these mutant genes.

Dr. Snyder, retiring president of the AAAS, is president of the University of Hawaii, Honolulu. This article is based on his AAAS presidential address, which was given on 28 December 1958, during the Washington, D.C., meeting.

Metabolic Blocks

Theoretically, we may conceive of a number of ways in which the lack, or partial lack, or inhibition of an enzyme may lead to altered metabolism, and thus, perhaps, to pathological consequences. I shall present some of these possibilities in simplified form, adding examples from genetic pathology in man where they are known or suspected.

Consider the sequential reaction

$$P \rightarrow Q \rightarrow R \rightarrow S \rightarrow T$$

in which each arrow represents an enzyme catalyzing the conversion of one substance to another. The specificity of each enzyme is considered to be the result of the activity of a single gene.

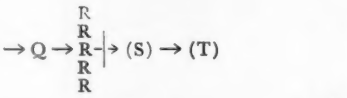
As an illustrative example of what is meant by a conversion catalyzed by one enzyme, xanthine (one of the purines) is oxidized to uric acid by the enzyme xanthine oxidase. The uric acid is then excreted in the urine. In the reaction shown in Fig. 1, note the essential similarity of xanthine and uric acid, and the addition of an oxygen atom brought about by the activity of the enzyme.

Returning to the sequential reaction

$$P \rightarrow Q \rightarrow R \rightarrow S \rightarrow T$$

consider now the gene that controls the enzyme that converts R to S. As a consequence of mutation, the mutant form of this gene may result in a somewhat different molecule, no longer enzymatically effective in facilitating the reaction, or at least no longer as effective as it formerly

was. One likely consequence of the metabolic block is that substance R will accumulate.

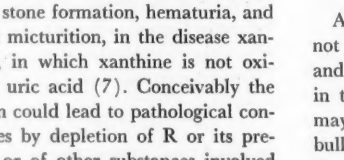


(The letters in parentheses indicate that the substance is no longer produced, or is produced in diminished amounts.)

The mere accumulation and storage of R may lead to pathological consequences. A probable example in man is Niemann-Pick disease, in which the genetic failure to degrade sphingomyelin causes this lipid to accumulate in the reticular and other cells, resulting in the manifold symptoms of the disease. A similar genetic failure to degrade one of the gangliosides leads to the storage of this lipid in the ganglion cells, with the resulting syndrome of infantile amaurotic idiocy (*5*). The recent discovery of a new phospholipid, malignolipin, found only in malignant tumors and never in normal tissues, may, if confirmed, eventually place cancer in this category (*6*).

Another possibility is that the accumulation of substance R may lead to its being excreted from the body. The excretion may be accompanied by symptoms, as stone formation, hematuria, and frequent micturition, in the disease xanthinuria, in which xanthine is not oxidized to uric acid (*7*). Conceivably the excretion could lead to pathological consequences by depletion of R or its precursors, or of other substances involved in the metabolism. In the last analysis, diabetes may well prove to belong in this general category.

It should be mentioned in passing that there is a genetic disturbance of quite a different sort that can also lead to excess excretion, in the urine, of a substance normally found there only in minute amounts, if at all. This disturbance is not a block in the direct metabolism of the substance excreted, but is rather a defect in the renal tubular reabsorption mechanism for that substance.



The precise genic action involved is as yet unspecified, but the phenomenon occurs in such diseases as glycinuria, cystinuria, and renal glycosuria (*8, 9*).

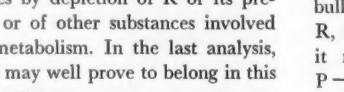
If the reaction P → Q → R is reversible, substance P rather than substance R may accumulate, leading to disease.

One type of glycogen disease of the liver is an excellent example, in which the genetic dysfunction of glucose-6-phosphatase prevents the reconversion of glycogen to glucose, but at a point several steps removed from glycogen itself; the reversible nature of the rest of the reaction results in the accumulation of glycogen (*10, 11*).

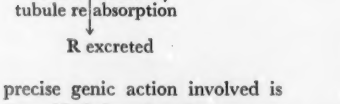
In some instances the mere absence of substance T may characterize the trait. Albinism, for example, is the result of the absence of melanin, due to the genetic dysfunction of tyrosinase. When this enzyme is lacking, tyrosine is not oxidized to dihydroxyphenylalanine, which latter substance normally proceeds through various conversions to melanin. Apparently the tyrosine is then metabolized through alternative pathways, with no further noticeable effects.

Alternative Pathways

Alternative metabolic pathways are not unusual in biochemical conversions, and this fact presents further possibilities in the production of genetic disease. It may be, for example, that although the bulk of substance P proceeds through Q, R, and S to T, some small amount of it normally passes through the steps P → v → w → x.



(The small letters are used to indicate that lesser amounts of substance P ordinarily follow this path.) If, then, the metabolic break occurs as before between R and S, and if substance P is thus accumulated, much more of it may be forced through this alternative pathway, and increased amounts of V, W, or X may cause pathologic effects through the altered patterns of substances in the cells.



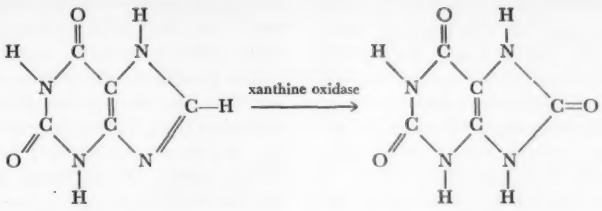
An example in human genetics is the severe mental disease phenylketonuria, in which phenylalanine cannot be oxidized to tyrosine, and as a result passes in large amounts through deaminating reactions which certainly derange the amino acid balance in the cells (*12*).

When a substance is forced through an alternative metabolic pathway, still other possibilities are opened up. When large amounts of W, for example, are available, some of this substance may in turn be diverted to a series of conversions not ordinarily followed: W → Y → Z.

Under such circumstances, Z may conceivably cause pathological effects. No example in man has been clearly established, but the development of the abnormal form of the glycolipid kerasin in Gaucher's disease may be due to a reaction of this nature. The pigments laid down in ochronosis and causing degenerative osteoarthritis in some but not all patients suffering from alcaptonuria could well be examples of this type of genetic pathological development.

Finally, the mutant gene may result not merely in the lack of the enzyme formerly produced, but in the presence of a demonstrably functional but somewhat different enzyme. We have become aware of the fact that when the gene responsible for an *antigen* mutates, a specific but different antigen usually results from the activity of the mutant gene. It is probable that a similar phenomenon occurs in mutations involving enzymes.

If, for example, the enzyme which formerly converted R to S is changed through mutation in such a way that it now converts R to A (a new substance), the presence of A may give rise to pathological consequences. The ten or more variant forms of hemoglobin (*13*), each of which may result in a greater or lesser degree of anemia, are instances of this type of genetic disease. Sickle hemoglobin, for example, differs from normal hemoglobin in *only one* of the nearly 300 amino acid units of the half molecule, one of the glutamic acid residues of normal hemoglobin being replaced by a valine residue in the sickle form (*14*).



Xanthine Uric acid

Fig. 1. Oxidation of xanthine to uric acid.

In this instance the enzyme controlled by the mutant gene accounts for a very slight alteration of amino acid sequence in the polypeptide chain. Even this alteration, however, is sufficient to cause the illness and subsequent death of those individuals having only this type of hemoglobin.

Inhibitors

In addition to the foregoing suggestions, which deal primarily with enzyme lacks that are dependent on recessive mutations in genes which normally produce functional enzymes, one other possibility should be mentioned. It is known that enzymes may be interfered with by inhibition, and it seems likely that the inhibitor may at times be a substance produced by a mutant gene which is not itself directly concerned with the development of the enzyme inhibited. Since the inhibition appears to be caused by an active, effective substance, we tend to think of genetic inhibitors in terms of *dominant* mutations which result in specific substances causing metabolic blocks.

While it is certainly conceivable that the production of an effective substance could in some instances be contingent upon the homozygous state of a recessive gene, most genes seem to be capable in single dose of elaborating reasonably adequate amounts of the substances, and are thus in some degree dominant to their alleles which fail to produce the active agents.

In the reaction below, the action of the inhibitor is indicated by a box around the enyzme.

$$P \rightarrow Q \rightarrow R \boxed{\rightarrow} (S) \rightarrow (T)$$

A probable example in medical genetics is the inhibition of the enzyme enolase in glycolysis, resulting in the disease hereditary spherocytosis (*15*).

Many complications may be envisaged in regard to inhibitions of enzymes. To cite just one of these, it is known that excesses of certain normal metabolites may act as inhibitors. In the reaction below, the mere accumulation of substance R as a result of the genetic dysfunction of the enzyme converting R to S may cause inhibition of the enzyme converting B to C.

$$P \rightarrow Q \rightarrow \overset{R}{\underset{R}{R}} \dashv (S) \rightarrow (T)$$

$$B \boxed{\rightarrow R \rightarrow} (C)$$

An example in man is the greatly reduced pigmentation which occurs incidentally in individuals suffering from the severe mental disease phenylketonuria. The excess of phenylalanine, which is found in those who have this disease, has been shown to act as an inhibitor of tyrosinase, thus diminishing the conversion of tyrosine to melanin (*16*).

The foregoing series of reactions portrays in very simplified form some of the possible paths by which mutations resulting in enzyme dysfunctions may lead to genetic disease. An important underlying principle in these concepts is that once a gene has mutated, the mutant allele is henceforth copied in its altered chemical form just as faithfully as the unmutated gene was formerly copied in its original chemical structure, thereby leading to the incorporation of the new allele into the pool of genes of the species.

Environmental Effects

The metabolic blocks thus far discussed have a direct relation to the production of genetic disease. The relation, however, may not always be so direct, and the pathological consequences of a gene may manifest themselves only in specific environmental situations. It has recently been shown, for example, that a genetic deficiency of the enzyme glucose-6-phosphate dehydrogenase may cause an alteration in glutathione metabolism, resulting in an instability of reduced glutathione (*17*). As a consequence of this instability, the red blood cells are liable to hemolysis following the ingestion of certain drugs such as naphthalene, primaquinine, sulfanilamide, and nitrofurantoin. Thus an induced hemolytic anemia develops, which, though appearing to be environmentally produced, has a definite genetic basis. From a practical standpoint, an assay of blood cells for this enzyme may make it possible to detect those individuals who are drug-sensitive and would be harmed by these drugs.

There are innumerable potential interactions between hereditary and environmental influences. It should be kept in mind that not all inhibitors are under genetic control. In addition it should be recalled that many enzymes have a coenzyme, or prosthetic group, as a necessary adjunct to the protein core. Although the protein core is determined by a gene, the coenzyme is often of vitamin origin, and is thus, in man, at least, environmentally conditioned. It is conceivable, therefore, that an enzyme which in one individual is inhibited by a genetically produced substance may in another individual be inhibited by an environmentally provided agent. Similarly, an enzyme which in one person is rendered dysfunctional by a genetic defect of the protein core, or apoenzyme, may in another person be inactivated by an environmental lack of the coenzyme. As a result of these and other exogenous effects, "phenocopies" may be produced, mimicking the genetic conditions. For example, nutritional siderosis appears to be a phenocopy of genetic hemochromatosis.

For many years I have predicted to my classes in medical genetics that the vitamin-deficiency diseases resulting from the nutritional lack of coenzymes would someday be found to be paralleled by similar diseases due to genetic deficiencies of the corresponding apoenzymes. This prediction has recently been fulfilled by the recognition of a genetic form of pellagra, designated as Hartnup disease (*18*). Classic pellagra is, of course, the result of a nutritional absence of the coenzyme containing niacinamide. In the genetic form there is apparently a dysfunction of the corresponding apoenzyme

involved in the metabolism of tryptophan. We may look forward to similar descriptions of genetic forms of scurvy, beriberi, and the rest. A genetic form of rickets, resistant to vitamin D and exhibiting hypophosphatasia, has been observed occasionally, and is the subject of a careful recent study (*19*). There is some evidence that it may prove to belong in the category of diseases resulting from a genetic defect in the renal tubular reabsorption mechanism, in this instance for phosphate.

Of course, the very fact that man requires vitamins in his diet in the first place is the result of gene-controlled enzyme dysfunctions apparently shared by all human beings. Most animals, for example, can synthesize L-ascorbic acid, by a series of steps, from D-glucose, and hence do not require ascorbic acid in their diets. Man and other primates, however, lack one enzyme in the series, and as a result are unable to accomplish the conversion of L-gulonolactone to L-ascorbic acid (*20*). Ascorbic acid thus becomes a vitamin for man: vitamin C.

In spite of the fact that genes are normally identical from cell to cell of the individual, the cytoplasmic constituents of the cells need not be equivalent. The unequal distribution, during mitosis, of mitochondria, microsomes, and other inclusions can result in the occurrence of identical genes in cytoplasmic environments which differ in concentrations of enzymes, substrates, and other materials from tissue to tissue. It is well known that the effect of a gene can be altered considerably by the environment, without any change taking place in the gene itself. In this way a given gene may produce an effect in one tissue and not in another.

In like manner, one gene may exert its influence at an early stage of the development of the individual while another may not be effective until a later stage. The consequences of the gene that conditions congenital ichthyosis, for example, are clearly detectable in the embryo, while the effects of the gene for Huntington's chorea are apparent only in later life. The explanation for this phenomenon appears to rest on a firm biochemical basis. Enzymes often compete for the same substrate. Equilibria in reversible reactions require time to be achieved, and the establishment of an equilibrium may free a substrate for a new conversion by a different enzyme. The accumulation of by-products may slowly reach critical levels at which the by-products may act as new substrates or as inhibitors.

Moreover, a biological protein is a mixed population of molecules of very different ages, some being very new, while others may be months old. Correlated with these differences in age are differences in the conformation of the molecules, involving such things as the formation of dithio bonds and the substitution of amino acids (*21*).

The descendents of a gene, then, may well be located in environments in the mature individual which are biochemically different from those in which the gene occurred in the embryo or the young organism. The effects of genic action could thus be quite understandably different at various times in the life history of a given individual.

It would seem to be a reasonable inference that genes do not exert absolute control over the presence or absence of specific enzymes but rather determine the potential development of particular enzymes and enzyme systems in particular environmental situations (*22*).

Thus the interlocking network of hereditary and environmental influences, which has long been obvious in the overt manifestations of traits and characteristics, is now seen to be equally operative in the basic biochemical and physiological processes of the cell itself.

Dominance

The concepts which I have discussed up to this point have an important bearing on our understanding of many Mendelian phenomena which were originally but vaguely understood. In particular, such terms as dominance, recessiveness, and epistasis have become clarified in the light of biochemical considerations (*22*).

In Mendel's original paper appears the statement (translated) ". . . those characters which are transmitted entire, or almost unchanged in the hybridization, and therefore in themselves constitute the characters of the hybrid, are termed the *dominant*, and those which become latent in the process *recessive*." Since Mendel's day these terms have been applied to the genes (Mendel's *elements*) themselves as well as to the characters.

For many years the fact that one gene of a pair may be dominant to the other was merely stated, not explained. Today a simple, reasonable explanation is possible in terms of biochemical activity. The primary action of a gene appears to be the control of the specificity of a substance such as an enzyme which is responsible for the catalysis of a particular step in the synthesis or degradation of some compound. A recessive mutation in a gene often results in the failure of the mutant gene to develop the enzyme.

Albinism in man has been shown to be dependent upon the homozygous condition of a gene which has been named *c*. Thus *cc* individuals are albinos, but both *CC* and *Cc* persons are normally pigmented. Gene *C* is thus said to be dominant to its allele *c*.

The enzyme tyrosinase is always identifiable in pigmented individuals, who have the gene *C*, but is not demonstrable in albinos, who lack this gene (*23*). It would appear that *C* is responsible for the elaboration of tyrosinase, while its mutant allele *c* fails to develop this enzyme. It is equally apparent that one dose of *C* is grossly as effective as two. This latter fact is not surprising when it is realized that enzymes function by facilitating biochemical conversions all out of proportion to the amount of enzyme present. Since a particle of enzyme, once its quantum of catalytic action has been accomplished, dissociates itself from the resulting compound and is available for further catalytic activity, it is apparent that a small amount of enzyme may be sufficient to accomplish complete or nearly complete conversion.

It is logical to infer, then, that within a given genetic milieu one dose of *C* in a heterozygous (*Cc*) individual can elaborate sufficient tyrosinase to convert the available tyrosine to melanin. Since two doses of the gene (*CC*) could accomplish no more than this, the genotype *Cc* is as effective as the genotype *CC* in the development of melanin, and *C* is said to be "dominant" to *c*.

Consider your vitamin intake as an analogy. If, in your childhood, each of your two parents had provided you every day with your vitamin requirements, you might have had more than your minimum needs, but you would not have suffered from vitamin-deficiency diseases. If only one of your parents had supplied your needs, you would also have been free from deficiency symptoms. But if neither parent had provided any vitamins, the effects of the deprivation would have become manifest.

In man it has been demonstrated by means of phenylalanine tolerance tests that about half of the phenylalanine-oxidizing enzyme is in an inactive or ineffective form in those who are heterozygous for the gene for phenylketonuria (*24*). Thus those who are carriers of the gene may be identified by a chemical

test, even though outwardly they are quite normal. Other instances of genetic disease must be studied along these lines in order to test the general validity of this principle. Among the diseases, in addition to those already mentioned, in which the enzyme lack or deficiency has been specifically identified, and which are available for such study, are acatalasemia, alcaptonuria, constitutional hepatic dysfunction, at least one form of cretinism, galactosemia, several forms of glycogen disease, hypophosphatasia, and one form of methemoglobinuria (*11, 25*).

In addition to behaving as obvious enzymes, the substances controlled by genes may in some instances act as antigens or inhibitors or hormones. It is tempting to postulate that the activities of even these substances may be but specialized forms of enzymatic activity.

In the case of antigens, where identification is made relatively simple by the ability of the substance to provoke the production of specific antibodies, the mutation of a gene responsible for an antigen nearly always results in the development of a different but equally specific antigen. Heterozygotes are thus readily recognizable by the use of appropriate antiserums, and dominance disappears.

Between instances with no dominance and those with apparently complete dominance are all grades of the phenomenon. By means of various biochemical or immunological tests, and sometimes merely by keen observation, it is becoming increasingly possible to identify heterozygotes (*23, 26*) and thus to move both genetic prognosis and preventive medicine from a statistical to an individual basis. It is reasonable to presume that eventually, by appropriate, though often subtle tests, all heterozygotes will be identifiable. This, too, is an area of research that offers many challenges.

Sequential Reactions

The occurrence of mutant individuals and the genetic study of these individuals and their families have on several occasions indicated the complex sequential enzymatic nature of a reaction originally supposed to be simple and direct. Conversely, the prior biochemical demonstration that a conversion involves several enzymes acting sequentially has suggested the possibility of several genetic types of a particular disease.

As an example of the first of these two principles I may call attention to the recent work on the blood-clotting mechanism (*27*). No longer can we accept the simple Morawitz theory of blood coagulation, in which it was assumed that prothrombin plus thromboplastin plus calcium ions results in thrombin, and that thrombin plus fibrinogen results in fibrin, which produces the clot. No longer can we automatically classify as hemophilia any genetic hemorrhagic disease with prolonged clotting time. The study of mutant individuals with bleeding disease has indicated that at least nine gene-controlled substances (presumably enzymes) are required for the thromboplastic conversion of prothrombin to thrombin, and that each of these trace proteins may become dysfunctional through mutation.

The superficially similar diseases involving the thromboplastic activity of the blood-clotting mechanism now include, in addition to classical hemophilia, Christmas disease, parahemophilia, deuterohemophilia, tetartohemophilia, SPCA deficiency disease, Hageman deficiency disease, Stuart deficiency disease, and factor X deficiency disease.

The second principle, involving the indication on biochemical grounds that genetically diverse forms of a disease may be expected to occur, is well illustrated in nonendemic cretinism with goiter. When the complex sequential enzymatic steps in iodine metabolism leading to the synthesis of thyroid hormones were worked out, it was apparent that the failure of any one of these steps was genetically possible. Careful investigation with this in mind (*28*) has revealed at least three types of the disease, and more may be expected to occur. In one of the described types, iodotyrosines cannot be produced from tyrosyl residues and iodide, apparently because of a dysfunction of an oxidative enzyme. In another type, iodotyrosines cannot be coupled into iodothyronines with sufficient speed. In the third type, a dysfunction of the enzyme dehalogenase results in a failure of iodotyrosines to deiodinate.

Similarly, at least four genetic dysfunctions are now known among the six enzymes necessary for the interconversion of glucose and glycogen, and these result in four distinct forms of glycogen disease (*11*).

Other examples could be cited. It has in fact become very important to search for genetic heterogeneity in all diseases by appropriate methods (*29*). Therapeutic measures which may be of value in one genetic form of a disease are not necessarily successful in another, even though the overt symptoms of the two may sometimes be quite indistinguishable.

Studies of clinical features, age of onset, genetic mode of transmission, immunologic and biochemical patterns, and other techniques may aid in discovering genetic heterogeneity. The use of paper chromatography and electrophoresis has become of paramount importance in studies of this nature. Most recently, the development of techniques for separating individual human cells and growing them as pure clones in tissue culture has opened up new possibilities along these lines, as well as in the important area of the analysis of mutation rates (*30*).

Structural Anomalies

It has long been my contention (*31*) that structural anomalies are just as subject to interpretation on the basis of enzyme dysfunctions as are the storage diseases and other obvious metabolic disorders. It should be possible by appropriate biochemical methods to discover errors of metabolism in the development of such conditions as lobster claw, polydactyly, achondroplastic dwarfism, and multiple exostoses, even though, apart from the morphologic aberrations, the subjects appear to be in good health. This conviction is shared by others (*8, 32*), and it is now possible to document it in some instances.

The first clear indication that a simple, gene-controlled enzyme dysfunction can be the basis for a structural anomaly came when evidence was found for a defect in glycolysis in the red cells in hereditary spherocytosis (*15, 33*). In this disease the red blood cells develop as spherocytes, lacking the expandable biconcave surfaces of the normal red cells. As a result, the cells are osmotically and mechanically fragile, and rupture easily as they move sluggishly into the spleen and are held there.

In the presence of the appropriate gene, one of the enzymes responsible for glycolytic metabolism fails to function properly. Since the gene involved is dominant, the basic defect in spherocytosis may well be the result of an inhibition rather than an absence of the enzyme. The enzyme affected appears most likely to be enolase, which in normal glycolysis converts 2-phosphoglyceric acid to 2-phosphoenolpyruvic acid. The latter substance in its subsequent metabolism provides energy in the form of adenosine triphosphate (ATP).

When enolase dysfunction occurs as a

result of the activity of the implicated gene, the red cell can no longer build up adenosine triphosphate and maintain its usual store of chemical energy—energy necessary, among other things, for the maintenance of the integrity of the framework and the membrane of the cell.

Since the mature red cell appears to be the only cell of the body entirely dependent on glycolysis (*15*), the defect would be most noticeable in this kind of cell, although the mutant gene must, of course, be present in all the cells of the body. Moreover, the red blood cell, being readily accessible for study, is of paramount importance as a tool for the analysis of many metabolic errors, even though the clinical effect is most noticeable in other tissues. For example, phosphogalactose-uridyl-transferase was implicated as the enzyme deficient or nonfunctioning in galactosemia by studies of the red blood cells of children suffering from the disease, and this was only later confirmed in regard to the cells of the liver, where most of the damage is actually done (*34–36*).

Metabolic Interrelationships

Incidentally, biochemistry makes strange bedfellows of genetic diseases. Hereditary spherocytosis is now seen to be intimately related biochemically to galactosemia and the glycogen diseases through glycolytic metabolism, just as albinism, phenylketonuria, tyrosinosis, and alcaptonuria are all, surprisingly, biochemically related to one another through the metabolism of phenylalanine, one of the amino acids. In spite of the close biochemical relationships, however, the inheritance of such related disorders is quite independent and specific.

Since, of course, the metabolism of carbohydrates, fats, and proteins is closely integrated through the tricarboxylic acid cycle, it is well within the range of possibility that before too long the entire metabolic processes of man may be diagrammed as a single, elaborate biochemical pattern. Through the continuing study of more and more mutant individuals, each enzyme in the pattern will become identifiable in terms of the activity of a specific gene (a specific portion of a deoxyribonucleic acid molecule), and each genetic enzyme dysfunction will be related either to a mutation of that gene, resulting in a lack or modification of the enzyme, or to a mutation of a different gene, acting in such a way as to inhibit the activity of the enzyme.

The specification of the precise sequence of the steps in any reaction and the identification of precursors are enormously facilitated by the availability of mutants which block the various steps, since in the absence of such blocks the intermediary products are generally converted in the cell as rapidly as they are formed, and are thus difficult to detect. For example, the conjecture that phosphorylethanolamine is one of the long-sought, naturally occurring substrates of alkaline phosphatase was made possible by the availability of genetic instances of hypophosphatasia (*37*).

Woven into the over-all pattern there will be, of course, environmental threads in the form of vitamins and other coenzymes, and of such things as hydrogen ion concentration, inorganic ion strength, temperature, substrate concentration, drugs, and infections.

Moreover, such a biochemical pattern of genetic health and disease will not be restricted to "physical" traits. Already several "mental" anomalies have yielded to biochemical analyses. Phenylketonuria and infantile amaurosis, among others, occur as the result of single-gene enzyme dysfunctions, as already mentioned. Other mental disorders are at present being actively investigated from this standpoint.

It should perhaps be pointed out here that the metabolism of metallic elements is also involved in human disease and may be genetically interfered with. Examples are the disturbances of iron metabolism in hemochromatosis and in methemoglobinuria, of copper metabolism in hepatolenticular degeneration, and of potassium metabolism in family periodic paralysis (*11, 38*).

The delineation of the complete genetic and biochemical pattern of man that I have envisaged involves, of course, many difficulties; but it also offers many challenges and promises important rewards. To give just one example, it would be of the utmost value in the elucidation of the basic mechanisms underlying heart disease to be able to formulate the metabolic interrelationships that must exist between the lipids and the purines. The relative levels of uric acid, cholesterol, and phospholipids have been shown to be related to the development of atherosclerosis and coronary artery disease (*39*). Although the metabolism of each of these substances may be independently controlled by the activities of known genes, as in gout, xanthomatosis, and the lipidoses, respectively, some basic, underlying, genetic mechanism must surely exist which enzymatically conditions their interacting biochemical activities. A step in this direction may have been taken with the recent demonstration that familial amyloidosis represents an inherited aberrancy in lipoprotein metabolism (*40*).

The most promising basis for the ultimate formulation of a complete chemical-genetic pattern for human beings lies in the now apparent principle of the unity of biochemistry—a principle which states that the fundamental biochemical reactions are identical for all organisms thus far studied, from microbes to man.

Practical Applications

The growing awareness that the primary activity of a gene is the control of the specificity of a substance such as an enzyme is adding immeasurably to the precision of the various practical applications of medical genetics. I have discussed these applications (diagnosis, treatment, prevention, and genetic prognosis) elsewhere in detail (*41, 42*) and will add here only some suggestions regarding the emerging values of the principles discussed in this presentation.

It is clear that an understanding of the basic mechanisms of pathology is necessary for accurate differential diagnosis. In particular, the knowledge of the *basic genic action* involved will facilitate diagnosis, which is all too difficult in many diseases and aberrations at the present time. In those instances in which the biochemical steps between the primary activity of the gene and the resulting manifestation of the trait are few, the trait is likely to be readily diagnosable, and the primary activity may be subject to comparatively easy identification. But where the biochemical steps are numerous, with alternative pathways available, and with many opportunities for the impact of subtle or overt environmental influences, the resulting clinical picture may be complex and confused, and the basic genic action may be difficult to specify.

Another difficulty in the delineation of specific genic actions is to be found in those instances in which the effect of an individual gene is very slight. The effects which I have thus far discussed have been evident as marked phenotypic discontinuities. There are, however, genic activities in which the phenotypic effect of an individual gene is not readily discernible, consisting of only a very slight alteration of structure or function.

Where several or many such genes

affect the efficiency of the same enzyme or process, however, their cumulative effects may be quite appreciable. Groups of genes with small but similar cumulative effects are referred to as polygenes, and they appear to be of importance in the genetically determined portions of quantitative variation, both normal and pathologic. Special methods are necessary for the analysis of the genetic and biochemical activities of polygenes (*42*).

Each individual has a unique assembly of genes and will have his own mode of reaction to disease, whether it be presented through infection, trauma, stress, or malnutrition, or wholly from within through biochemical error. The conviction that the genetic constitution is involved to a greater or lesser extent in all disease will serve as a stimulant to look beyond the secondary aspects of pathology and to search for the primary genic action in each case. Once this has been determined, both diagnosis and treatment will be facilitated. In this connection care must be taken that in assaying correlations between biochemical observations and clinical manifestations, cause is not confused with effect.

It is well to recognize that there is at present one apparent limit to potential therapy in genetic diseases. Although inhibitors, whether genetically determined or not, may be subject to environmental control, and although coenzymes and substrates may be provided nutritionally and in other ways, the basic protein enzymes can be gotten into a cell only by building them there. The building process is determined by the presence of appropriate genes.

As a consequence there would appear to be a residue of diseases, resulting from mutant gene-controlled absences of requisite, potent enzymes and apoenzymes, for which there is at present no apparent "cure" in the usual sense. The ingenuity of biochemists and physiologists may in the future, however, make it possible to devise alleviation even for these fundamental errors.

The increasing ability to identify carriers of mutant genes will add to the precision of practical applications in prevention and in genetic prognosis, by bringing to light precursory, preclinical and constitutional stigmata which can be employed in these applications. The elucidation of indices of predisposition, whatever their origin, can be of service in identifying those environmentatl factors which may act as precipitating causes of clinical manifestations. Such identification may well prove to be of primary value in the ultimate control of disease (*43*).

The prospects for the eventual understanding of human health and well-being grow ever brighter, and to no one is more appreciation due for his fundamental contributions to this field than to Sir Archibald E. Garrod.

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International Geophysical Year

The second part of a two-part summary of IGY activities covers heat and water, the earth, and data exchange.

Hugh Odishaw

The first part of this article (*1*) outlined the scope of the IGY effort and attempted to summarize some aspects of the work dealing with the physics of the upper atmosphere, including solar and interplanetary medium relationships. This second part (*2*), also drawn from reports of the IGY scientific community and illustrative of their activities, takes up the story of typical findings in the areas of the heat and water regimen (meteorology, oceanography, and glaciology) and of the earth sciences (seismology, gravity, and longitude and latitude determinations). It also summarizes the status of data flow, for the IGY was above all a synoptic data effort, and then takes a look at post-IGY programs growing out of the IGY.

Heat and Water

Just as studies of particles, radiations, and fields benefited during the IGY from its concerted studies in a half a dozen fields of science, the opportunity for simultaneous investigations in oceanography, glaciology, and meteorology brought with it possibilities of better understanding of the complex of heat and water. While the three chains of pole-to-pole meteorological stations yielded the raw data from which major atmospheric circulation patterns can be devised, some eighty oceanographic vessels provided data of various kinds for delineation of oceanic circulation systems. Carbon dioxide was measured in atmosphere and ocean. Sea-level measurements, humidity determinations, and snow and ice estimates all tie into establishment of the role of water in all three of these states, relating inevitably to the heat budget and currents.

Meteorology. To explore more completely atmospheric circulation patterns, the IGY upper-air sounding program was characterized by two major efforts: (i) the filling in of major geographic gaps in the world networks, particularly in and near Antarctica, and (ii) the extension in altitude of balloon soundings up to about 100,000 feet.

Prior to the IGY emphasis on higher soundings, routine 600-gram balloon flights averaged about 71,000 feet. It should be noted, however, that the U.S. Weather Bureau and the balloon manufacturers have engaged in a continuing program to improve balloon performance, and that during the IGY an improved 600-gram balloon was used at all stations for the 0000Z observations and at one-third of the stations for the 1200Z observations. In pre-IGY tests, 80 percent of the 600-gram balloons had an average burst altitude of 82,020 feet, with a highest altitude of 99,670 feet. A high-performance 800-gram balloon was used at two-thirds of the stations for the 1200Z observations (chosen because this is the observation used for preparation of the IGY world weather maps); 24 of these balloons tested at the beginning of the IGY had an average burst altitude of 107,180 feet. During the IGY the 600-gram balloons have performed well, with average burst altitudes of about 83,000 feet; average altitude attained with the 800-gram balloons was about 90,000 feet. This program has achieved its objectives well enough to allow routine preparation of 10-millibar maps for stratosphere circulation studies.

Much was learned about antarctic weather; this is the first time such data have been collected to any appreciable extent. The coldest part of our planet is not at the South Pole but some 400 miles westward. Near there, Soviet scientists recorded a low of minus 124°F on 17 August 1958. The South Pole station was the coldest of the United States–IGY stations, with a minimum of minus 102.1° and an annual average of minus 56°F. Byrd station recorded a low of minus 82°, a maximum of plus 24°, and an average of minus 18°F; wind averaged 20 knots from the northeast, with maximum of 83°. The many overcast days during the winter contributed to making the weather environment there the worst of that at any of our stations.

The weather of Little America and Ellsworth stations was similar to that at the South Pole station but somewhat warmer, while at the Wilkes station the lowest temperature was minus 27°F. United States Weather Bureau scientists at Little America report a five-degree rise in annual mean temperature there over about fifty years—about one-half that noted at Spitzbergen in the Arctic—confirming a belief in the warming trend of the last few decades.

Beyond the extensive measurements of temperature, pressure, wind speed and direction, humidity, precipitation, and so on, made in programs conducted synoptically around the world, the IGY program embraced special studies. Thus, the United States program included research in solar radiation, ozone, carbon dioxide, and natural and artificial atmospheric radioactivity (see Fig. 1). Special solar radiation studies were conducted at seven Antarctic stations (Fig. 2), at the two ice stations in the Arctic Basin, and on Mauna Loa, Hawaii. Measurements were made of the intensity of total solar and sky radiation on a horizontal surface, intensity of the direct solar beam, natural illuminations, surface albedo, and hemispherical and net radiation.

The large amount of data stemming from this work is being reduced and processed. One of the observations at hand has to do with atmospheric purity: It turns out that the purities at Little America and Mauna Loa are comparable, while at the South Pole the sky is even clearer. Preliminary results from Station Alpha in the Arctic indicate the great importance of long-wave radiation from overcast skies in melting, for melting proceeded much more rapidly under overcast skies than beneath clear skies and in bright sunshine; conversely, refreezing may occur under clear summer skies because of increased outgoing radiation.

At Little America station, both surface concentrations and total ozone were measured. United States Weather Bureau scientists have analyzed some of the

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data (Figs. 3 and 4). They point out that the data are yet tentative, subject to further calibration of the equipment. Total ozone was observed with a Dobson ozone spectrophotometer, while the surface values were obtained with equipment developed by V. Regener (University of New Mexico) which employs the potassium-iodide–sodium-thiosulfate method with electrolytic titration.

During the winter months, the total ozone averages shown in Fig. 3 were based on two to four measurements taken on the full moon; averages for the remaining months are based only on measurements taken on the direct sun.

A marked feature of the annual variation in surface ozone (Fig. 4) is the rapid rise of ozone in March and April, when the sun leaves, and the slow decrease beginning in September after the sun returns. The dependency of surface ozone on wind direction is shown in Fig. 5, for June 1957. The "ozone rose" is drawn in terms of deviation in percentage from the average monthly concentration of 64 micrograms per cubic meter of air.

The usual diurnal variation of surface ozone concentration found at middle-latitude stations shows an ozone maximum during the late morning or early afternoon with a minimum during the late evening or early morning hours. This variation is believed to be due to the change of the vertical "Austausch" during the day. Afternoon convection activity permits the ozone to be carried down from the upper layers, but during the evening the lower air layers become stratified and the downward transport weakens. Eventually the surface ozone is destroyed more rapidly than it can be replaced from above, and the concentration may drop almost to zero. At mountain stations this diurnal variation may be wholly absent or it may be influenced by the diurnal variation of the mountain-valley wind.

The hourly values of ozone concentration for Little America are presently available only for the months of April to November 1957, inclusive. The results of a harmonic analysis of this data are shown in Table 1.

The diurnal variation found at Little America differs markedly from diurnal variations reported at middle-latitude stations. During the winter months the maximum occurs during the early morning, at about 0300 hours (165th meridian time), but during the spring it shifts to 0600 hours. The amplitude of the variation is rather uniform during the winter but increases by a factor of three in September and then decreases again during the spring.

As a result of the IGY, daily weather maps of the entire globe will be prepared; the United States is assigned responsibility for the Northern Hemisphere; South Africa, for the Southern Hemisphere; and the German Weather Service, for the equatorial belt. Daily maps at two levels—sea level and 500 millibars—will be prepared. It is expected that the IGY world weather maps will be available after an interval of one or two years.

Oceanography. Two major objectives of the oceanographic program were the study of the sea-level changes and oceanic water budget and the study of water masses, particularly current systems. In addition, of course, much related work was included during the IGY cruises—for example, bathymetry, marine geological investigations, biological work, and geochemical investigations. For the study of the water budget, more than 350 tide gauge stations were operated by 25 nations. In addition to tide observations, instruments were installed at some stations to record the long-period ocean waves, variations in atmospheric pressure, and continuous records of air temperature. At as many locations as possible, the temperature of water to depths of 900 feet was measured with bathythermographs (Fig. 6), and water samples were taken for chemical analysis. These observations were designed to permit volumetric corrections to be applied to the observed sea-level fluctuations in order to obtain the true mass fluctuations.

About 80 research vessels, of 20 countries, participated in the cruise part of

Fig. 1. A U.S. Weather Bureau observer checks the plastic shield of a Schultze radiometer. To the right is a Suomi ventilated net radiometer. The instruments in the background are a hip-roof shelter for thermometers, an anemometer and wind vane, a tipping bucket rain gage, and a weighing rain gage. [National Academy of Sciences]

Fig. 2. Kipp and Zonen pyrheliometers used by Herfried Hoinkes of Austria, IGY meteorologist, at Little America station, Antarctica. The pyrheliometers face upward to measure incoming, and downward to measure reflected, thermal radiation. In the background is a "sun pillar"—an optical phenomenon created by the sun shining through fine ice crystals in a clear sky. [Photograph by Herfried Hoinkes]

the program. Many expeditions which involved direct cooperative participation by ships of several countries were conducted; for other parts of the program, oceanographers agreed among themselves on the timing and tracks of cruises to yield synoptic and adequate spatial coverage of the ocean masses under investigation.

An earlier article on the IGY (*3*) described the discovery of the current beneath and opposite the Gulf Stream, in an early cruise sponsored by the Woods Hole Oceanographic Institution and the National Institute of Oceanography, England, and mentioned other early IGY results. The Scripps Institution of Oceanography finished three IGY cruises, the first of which was briefly described in the same article (*3*). The other two cruises were planned to study the Equatorial Undercurrent and Countercurrent in the eastern Pacific. J. A. Knauss reports that the Undercurrent, first investigated in 1954, is centered at the equator and is at least 3500 miles long, with a transport of the order of 30×10^6 cubic meters per second. The highest velocities observed were at depths of 100 to 113 meters and were between two and three-and-a-half knots. The Scripps research vessel *Horizon* and the *Hugh M. Smith* of the Pacific Oceanic Fisheries Investigation participated in the second Scripps Institution of Oceanography–IGY cruise, called Dolphin.

In the third Scripps cruise, Doldrums, Knauss found that the Pacific Equatorial Countercurrent was far more extensive then had been suspected earlier on the basis of calculations of the geostrophic current. The direct-current observations employed in the IGY cruise showed that the Countercurrent extends below the thermocline and actually transports more water below the thermocline than above it; the total transport was found to be about 50×10^6 cubic meters per second.

The measured eastward transport in the equatorial Pacific is estimated to be at least three times that estimated earlier by Sverdrup. This calls for a renewed investigation of the water balance and mass transport in the equatorial Pacific.

Much information on water mass and currents will be obtained not only by means of the direct methods (Swallow float, parachute drogues, current wheels, anchored buoys, and so on) but also from the study of temperature distribution, concentrations and distribution of the various chemical solutes, and radioisotopes. Analysis of cores of bottom sediments will provide clues to past circulation patterns. For example, sediment cores collected in the Arctic Basin before the IGY, at ice island T-3, and in the Atlantic provided information leading to a recently developed theory of glacier fluctuations by M. W. Ewing and W. Donn, of the Lamont Geological Observatory.

Significant contributions to knowledge of marine topography resulted from the bathymetry undertaken on IGY cruises and also from observations from the drifting ice stations in the Arctic Basin. R. L. Fisher and H. W. Menard, of the Scripps Institution of Oceanography, have reported on their exploration (during the first Scripps Institution of Oceanography–IGY cruise, Downwind of Nasca Ridge, a submarine mountain range extending southwest from just outside the Peru-Chile Trench off central Peru for a distance of at least 600 and possibly 1000 miles. Nasca Ridge was known previously only from several spot shoal soundings and a few echo-sounding crossings. Seismic refractions, heat-flow measurements, dredging, and coring completed the exploration of the ridge.

The Peru-Chile Trench was extensively explored, and heat-flow measurements were made near the trench, in the basin to the west, and in the Tuomotu Archipelago and East Pacific Rise. All told, 32 successful heat-flow observations were made—more than had been made previously. R. R. Revelle and R. Van Herzen reported that the highest values, 3 to 7×10^{-6} calories per square centimeter, were observed on the East Pacific

Rise. An indication was obtained of a trend toward much lower values near the axis of the Peru-Chile Trench, to the east. The study of these values of heat flow, particularly in relation to the topography, promises to advance the understanding of the structure of the general area.

Extensive areas were discovered where there existed a sludge containing manganese, iron, cobalt, and copper, in concentrations suggesting an ore value of about $500,000 per square mile. Aside from the possible economic importance of these ores, the understanding of how these metals are concentrated, probably by biological processes, will bear on our understanding of the geochemistry of the oceans.

In the Arctic Basin, Lamont scientists on Station A discovered a submarine ridge parallel to the Lomonsov ridge and lying about 85°N, in the vicinity of 166° to 168°W. The ridge is about 5000 to 6000 feet high; the full linear extent (at least 50 miles) is not yet known.

The Woods Hole vessels *Atlantis* and *Crawford* completed exploration of additional sections in the Atlantic Ocean, providing a coverage during the IGY more extensive than ever before. Woods Hole scientists have also engaged in a comprehensive geochemical program, and water samples have been secured for analysis of H^3, C^{14}, Sr^{90}, Sb^{125}, Cs^{137}, Ce^{144}, and Pm^{147}.

The *Vema* (see Figs. 7 and 8) of the Lamont Geological Observatory completed a 10-month IGY cruise. The two-ship seismic profiles were an important feature of the work; these were made in cooperation with *Atlantis* in the Red Sea. Lamont scientists have also taken many large-volume water samples for C^{14} and H^3 analysis. The *Hidalgo* of the Agricultural and Mechanical College of Texas completed a 60-day cruise in the Gulf of Mexico and Caribbean Sea, for study of currents. The *Brown Bear* of the University of Washington completed a second IGY cruise in the Northwest Pacific, where anomalous warm-water masses were studied, deep-water samples were collected in the Aleutian Trench, and studies were made of water exchange between the Bering Sea and the Pacific Ocean.

United States Navy Task Force 43 vessels in the Antarctic were able to make several crossings of the Antarctic Convergence, taking bathythermograms and water samples. About 190 oceanographic stations have been obtained since the pre-IGY exploratory cruise of the *Atka*. In addition, at Little America and near Hut Point, McMurdo Sound, stations were reoccupied over a period of months. Both at Little America and at Hut Point there was observed a rapid summer decrease in salinity, reflecting melting of pack and shelf ice, with warming confined to the upper layers. In autumn, temperatures rapidly reverted to spring values but salinity responded more slowly.

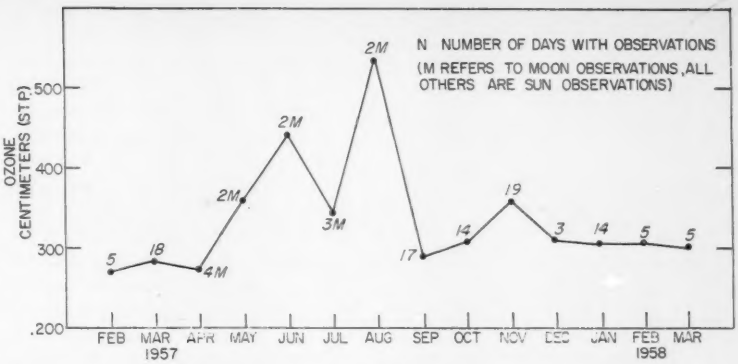

Fig. 3. Mean monthly total ozone values, Little America V (78°S, 162°W). [U.S. Weather Bureau]

Glaciology. Glaciers are among the most sensitive climatic indicators in nature. Past climates and climate fluctuations can be read from the snow and ice strata deposited from year to year, and annual variations in accumulation or shrinkage and in advances or retreats of the ice front provide keys to past and current climatic trends. During the IGY, glaciologists of 28 countries are making observations covering all the known ice areas of the world, including the great ice sheets of Greenland and Antarctica and a large number of valley glaciers in both polar and equatorial regions.

At the IGY Byrd station in the Antarctic a deep drilling program reached a depth of 1013 feet. Because of the relatively small annual accumulation of snow in the Antarctic, ice at 1000 feet below the surface at Byrd station is roughly equal in age to ice at the 2000-foot level in Greenland. However, the Antarctic cores are more difficult to date. In Greenland, the annual layers of snow are generally marked by a thin crust of refrozen summer melt; in the Antarctic, the annual layers are thinner and more closely packed, and there is often little or no summer melt. Careful chemical analysis may be needed to date the deep-lying cores, but it is estimated that the ice removed from the Byrd station 1000-foot drill hole fell as snow about the time of Charlemagne's birth.

At Little America, approximate ice temperatures at various depths were as follows: at 55 feet, −9.9°F; at 85 feet, −8.7°F; and at 130 feet, −8.0°F. This increase in temperature with depth is caused by the conduction of heat from the warm ocean below the 800- to 950-foot-thick ice shelf. The gain of heat at

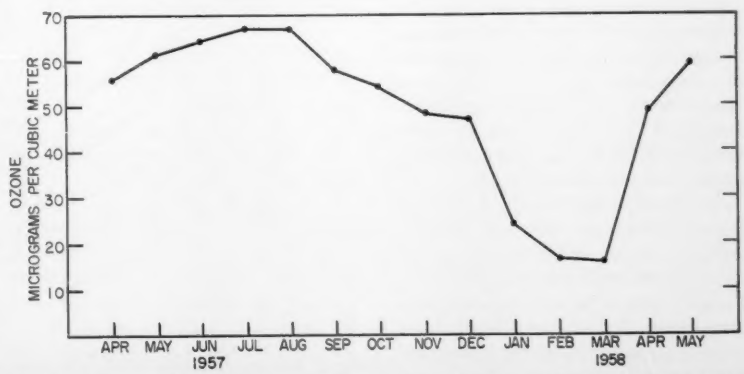

Fig. 4. Mean monthly surface ozone values, Little America V (78°S, 162°W). [U.S. Weather Bureau]

Table 1. Harmonic parameters for diurnal ozone concentration variations for the year 1957. [U.S. Weather Bureau]

Month	Amplitude ($\mu g/m^3$)	Time of maximum of the oscillation (hr after midnight)
April	2.7	2.0
May	0.6	2.1
June	2.2	2.6
July	2.0	2.9
August	1.9	2.7
September	6.1	2.9
October	2.6	4.0
November	1.2	5.5

the top of the shelf, however, is only 1 percent that of the average loss to space by radiation and so does not serve to ameliorate the climate very much. The "barrier" or edge of the shelf near Little America moves seaward about five feet a day. Stakes have been located across two ice valleys for movement-rate studies. Precise measurements made in February 1958 by A. P. Crary across "Crevasse Valley," between Little America and the barrier, showed that the 11,500-foot-long line laid out 375 days earlier had stretched 14 feet; this confirmed earlier observations showing that the valley is widening and that its underlying ice is becoming thinner.

To study the properties of larger areas of the great Antarctic icecap as well as other phenomena, United States–IGY Antarctic scientists completed three major traverses which covered a total of over 4000 miles out of the IGY Little America, Byrd, and Ellsworth stations.

The Ross Ice Shelf traverse from Little America covered a distance of 1440 miles in 113 days. It found that the shelf thickness varies from 800 to 950 feet, near Little America, to 1000 to 1100 feet west of Roosevelt Island and gradually increases to 1400 feet at the Beardmore Camp. The shelf floats but is grounded at Roosevelt Island and probably at other shallow areas. The ocean depth varies from 2000 feet at Little America to 2600 feet near Minna Bluff and then decreases south toward the Beardmore.

The Byrd traverse covered 1180 miles from 19 November 1957 to 20 February 1958 (see Fig. 9). It found that from the boundary of the Ross Ice Shelf to the Sentinel Mountains the underlying topography is alpine, with ice thickness varying between 2000 and 9000 feet. All but a few peaks of the rock floor are at present below sea level; the major portions are far enough below sea level to be under water even if the ice were removed and the land were allowed to rise, as it would without its great burden of ice. The second leg of the Byrd station traverse shows quite a different picture—a smooth bottom, great ice thickness of 7500 to over 11,500 feet, and broad gravity anomalies. The underlying rock along the final leg of the traverse, southwest and then west from the Sentinels, shows still another character. Surfaces there are very rough and mostly above sea level, in several places breaking the ice surface to form nunataks. One hundred miles east of Byrd station, ice 14,000 feet thick was found resting on a rock bed 8200 feet below sea level. This is believed to be the thickest ice layer measured anywhere in the world.

The Ellsworth traverse investigated the Filchner Ice Shelf and the inland ice of Edith Ronne Land. In addition to making glaciological studies, the Ellsworth party investigated mountains and rock outcrops in and near its route of travel. An important goal of this traverse was to occupy a point that could be reached by the Byrd station traverse of 1958–1959, thus providing a link across which data could be correlated. The traverse party traveled 1250 miles in 81 days. The party deviated about 120 miles from the planned route to make geological studies and collect rock specimens at a newly discovered mountain range, at 82°30′S and between longitudes 50° and 54°W, which may be part of the Pensacola Range (Fig. 10). Black stratified bands were noted high on the mountains, and a 5000-foot escarpment was discovered on the southern side. Evidence of mineralization was present in the form of abundant green malachite stains. Some of the bright green stains were visible at 100 yards. Large ice-free areas also were found along the northern foot of the range. One of these dry valleys contained a fresh-water lake about 100 yards in diameter, partly ice-free, caused undoubtedly by melting of snow in contact with the dark ground, which heats rapidly in the brilliant sunshine. The lake contained abundant plant life, and specimens were collected for botanical analysis.

A 2500-foot-high, ice-covered island extending for about 230 miles south and west from Gould Bay was discovered. Seismic soundings near its eastern ex-

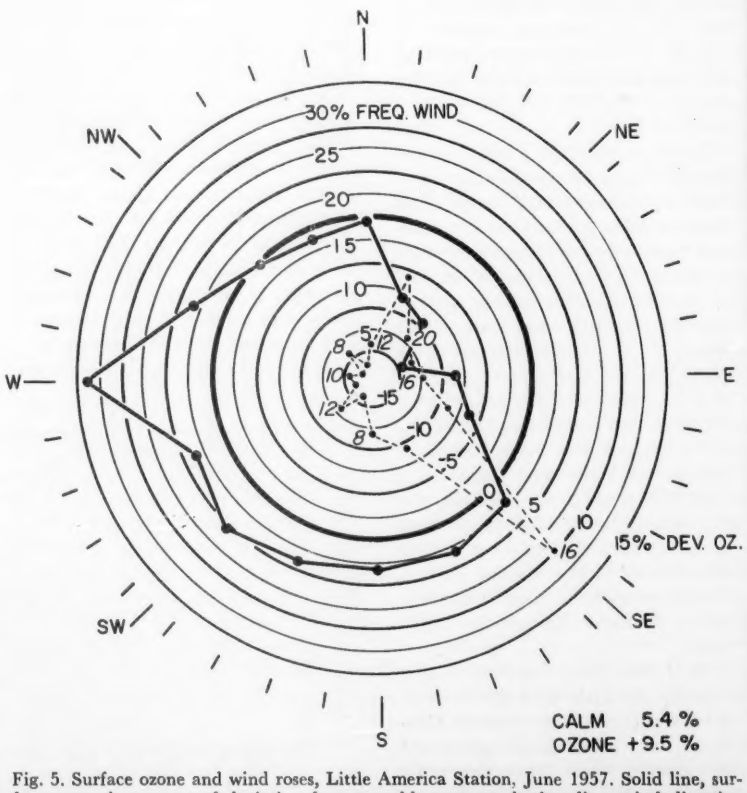

Fig. 5. Surface ozone and wind roses, Little America Station, June 1957. Solid line, surface ozone in percent of deviation from monthly average; broken line, wind direction frequency in percent; numerals, average wind speeds in knots. [U.S. Weather Bureau]

treme showed the land surface beneath the island's ice mantle to be at about sea level. Other islands, whose contours were not fully delineated, were seen still farther westward. Under the Ice Shelf a deep trough was detected extending inland from the vicinity of the Belgrano station, located 35 miles east of Ellsworth station. The bottom of the trough averages 3500 feet below sea level. After heading southward from Belgrano for some distance, the trough swings southwesterly, passing between the island and the newly discovered mountains. It continues beyond the southerly limits of the traverse.

The various determinations of ice thickness in Antarctica indicate that perhaps 40 percent more ice, (or almost 4.5×10^6 cubic miles) is present than was estimated before.

An ice-deformation project, concerned mainly with the measurement and mapping of deformed ice features of the Ross Ice Shelf between Roosevelt Island and the Bay of Whales, also was undertaken, under the direction of J. A. Zumberge of the University of Michigan. Large-scale topographic maps were made of selected areas so that details of change in the shelf-ice surface could be recognized in future years. Zumberge reports that several deformational features were recognized during the studies: (i) ice anticlines produced by horizontal tensional stresses; (ii) the transverse crevasses lying across the anticlinal axes, produced by horizontal tensional stresses; and (iii) the products of shearing action. Thermal studies and meteorological observations were also made during the project.

The Pleistocene glacial chronology of the McMurdo Sound region was studied during the 1957–1958 antarctic summer season by a two-man field party, led by Troy L. Péwé, of the University of Alaska. Péwé found, by examination of the glacial deposits in the region, that both the alpine and outlet glaciers have fluctuated widely in the geologic past. The two groups of glaciers are now independent, but in the past they merged to fill McMurdo Sound with ice. At several times in the latter part of the Pleistocene epoch many large lakes formed when valleys were blocked by glaciers or glacier moraines. These valleys are now dry, but shore lines, deltas, lake clays, and evaporite deposits (mirabilite) remain to attest to the former existence and extent of these lakes. A comparison of the present positions of the fronts of many glaciers of the McMurdo Sound region with the positions of the same fronts shown in photographs taken 46 years ago reveals that very little or no change has taken place in this almost half-century interval. Adjacent to many alpine glaciers are small ice-cored lateral moraines about 100 feet high. These moraines are extremely fresh and may represent minute glacial advances of the last few centuries.

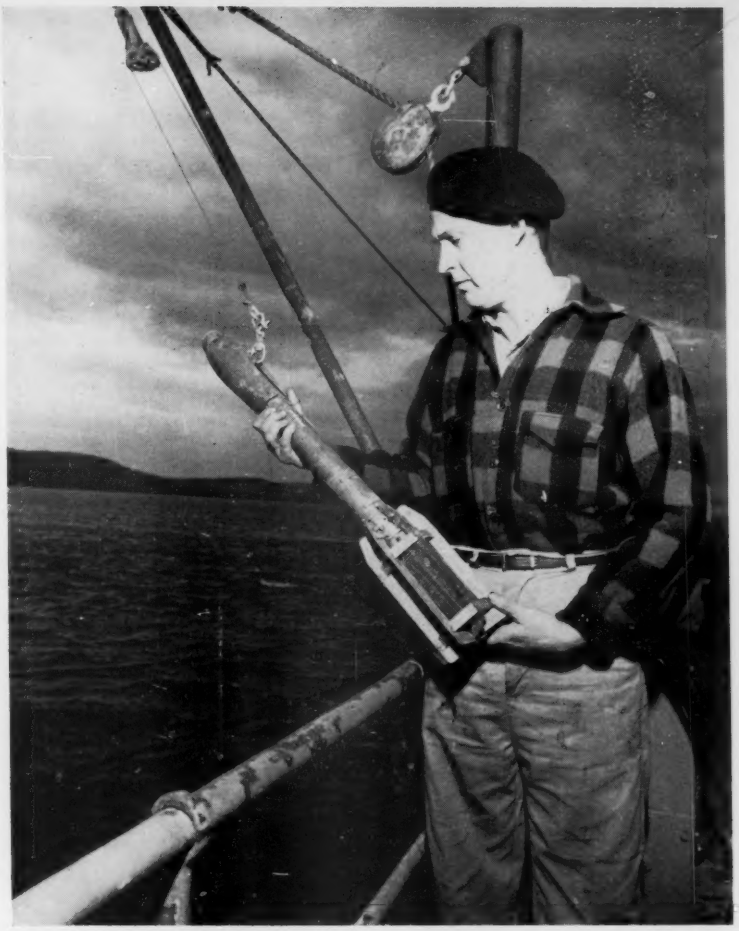

Fig. 6. An oceanographer prepares to lower a bathythermograph over the side of the research vessel *Vema* of the Lamont Geological Observatory. Bathythermographs record the temperature of the water at depths to 900 feet. [National Academy of Sciences]

The glaciology program also includes an effort to determine the present pattern and magnitude of shrinkage or growth of glaciers in the United States. Two teams of scientists are studying the Blue Glacier situated in Olympic National Park (Fig. 11). An important finding to date is the unexpectedly high precipitation in the area. E. LaChapelle of the University of Washington reports that, judging by records obtained during the first six months of the operation, it may well be that Mount Olympus is the wettest area in the continental United States. In January 1958, for example, snow accumulated on Blue Glacier to a depth of 120 inches, with a water equivalent of 30.44 inches, and by the end of February, 417 inches of new snow had fallen. R. A. Sharpe of the California Institute of Technology reports that seismic soundings indicated a maximum thickness of the glacier of 920 feet. Maximum surface movement was found to be about 5.9 inches per day.

Additional glaciological studies were carried out in other parts of the western United States, principally at South Cascade Glacier in the Cascade Mountains, at Grinnell Glacier in Glacier National Park, at Nisqually Glacier in Mount Rainier National Park, and in other national parks, including Yosemite National Park. The McCall Glacier in the Brooks Range, the Lemon Glacier near Juneau, and parts of the Alaska Range were also studied by United States–IGY glaciological teams.

Seismology. During the IGY, the United States undertook three major programs in seismology: study of the earth's crust, largely by means of explosion seismology on land and sea; study of the earth's interior by means of earthquake seismology, with special attention to new long-period seismometers; and measurements of the ice thickness in Antarctica by seismic traverse parties.

As part of the study of the earth's crust, M. A. Tuve and H. E. Tatel of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington undertook an expedition to the Andes in Chile and Peru. Large explosions (40 to 60 tons) used in copper mines were observed near Chuquicamata, Chile, and Toquepala, Peru. The indications are that the depth to the mantle in Peru in a region where the elevation averages 9000 feet is about 34 kilometers, whereas in Chile, in a region where the average elevation is 5000 feet, the depth to mantle is more nearly 55 kilometers. These findings are not in agreement with the simple theory of isostasy; however it has been suggested that the lofty mountains of Peru may be supported by a network of fine roots penetrating to great depth into the mantle. The work in the Andes served to strengthen the belief of the Carnegie group that the old concept of a broadly featureless and uniform upper region of the mantle is an oversimplification.

Crustal studies have also been carried out by the Wisconsin group under G. P. Woollard. In 1957, this group made seismic profiles in the Mexican plateau. Under average elevations of 5000 feet, the depth to the Mohorovicic discontinuity was calculated to be about 40 kilometers. Detailed work near the shot point revealed two layers overlying the "normal" (6.1 kilometers-per-second) crustal layer: 1 kilometer of 3.3-kilometers-per-second and 5 kilometers of 5.1-kilometers-per-second crustal layer. In the summer of 1958, this group made seismic profiles along a gravity high (+ 10 mgal) on the Keweenaw Peninsula in Michigan, along a gravity low (– 40 mgal) in northern Wisconsin, and in a region of zero anomaly in Arkansas. Woollard reports that the respective depths to the Mohorovicic discontinuity were found to be 35, 37, and 43 kilometers. As in the Mexican plateau, a layer with thickness of 1 to 2 kilometers and velocity of less than 5 kilometers per second was found in each of these three areas. The need for careful attention to such layers has been emphasized by Woollard, Press, and others.

As part of the oceanographic work of the Scripps Institution of Oceanography during the Expedition Downwind (21 October 1957–28 February 1958), seismic refraction and reflection studies were made by R. W. Raitt and G. G. Shor. Among the findings of this group were the thinnest (4 kilometers) and thickest (15 kilometers) crustal sections ever measured in the Pacific. Careful work revealed the presence of a layer of intermediate velocity (4 to 6 kilometers per second) between the sediments and the "normal" crustal layer.

Heat flow ranged over a factor of 50, demonstrating interesting correlations with seismic determination of crustal thickness. For example, on the East Pacific Rise, where heat flow is greater than in most areas, the crust is thicker and the seismic velocity of the layer presumed to be the mantle is nearly 7.6 kilometers per second. These correlations are being studied at the present time. The vital role played by many phases of the oceanographic program of this expedition is worth noting. Temperature, salinity, depth of water, and heat-flow measurements are all essential to the reduction and understanding of seismic data.

Another part of the IGY program has been the installation of a world-wide network of a special long-period seismometer of a type recently developed at the Lamont Geological Observatory and the California Institute of Technology. These instruments have revealed the existence of important energy components in seismic waves with periods greater than 50 seconds. These long waves in-

Fig. 7. A deep-sea camera is lowered over the side of the research vessel *Vema* of the Lamont Geological Observatory. This camera takes from 100 to 200 photographs of the ocean bottom at a single lowering, on 35-millimeter film with FT-118 strobe light for illumination. A transducer sends up a sound signal when the camera comes in contact with the ocean floor. [National Academy of Sciences]

clude surface waves with periods of 600 seconds and low-velocity waves with periods of 200 seconds, which are as yet unexplained.

Two extensometers, or strain seismometers, have been installed in South America (Chile and Peru) by Hugo Benioff of the California Institute of Technology. These instruments, capable of measuring a strain equivalent to a change in distance of 1/10 inch in 2000 miles, also serve as long-period seismometers and, as such, have measured long-period waves from earthquakes and the longer period (12-hour) strains due to earth tides. The site chosen for the extensometers in Peru has proved to be an unusually quiet site for a seismometer.

Seismograph stations at four United States stations in Antarctica have provided the first seismic records from this area. Records from these stations, which fill a gap in the previous seismic network, will make it possible to confirm and modify existing travel-time curves for the Pacific region.

The Wilkes station, whose seismograph was installed under the guidance of Frank Press of the California Institute of Technology, has a very special locality. This station is so situated that it is diametrically across Antarctica from the tip of South America. The direct path from an earthquake in this area to Wilkes must therefore follow a trans-antarctic path. When such an earthquake of proper size has been recorded at Wilkes and when the records have been analyzed, it will be possible from the study of group velocities to determine whether the structure of Antarctica is essentially continental or oceanic —that is, whether Antarctica is a continent or an island group.

This same problem has been attacked by seismic traverse parties, whose work has revealed the antarctic ice sheet to be much thicker than had originally been supposed. Measurements made by seismic traverse parties in the antarctic summer of 1957–1958 and in the pre-IGY period demonstrated that the rock underlying the ice sheet is considerably below sea level in many regions. The traverse party from Little America led by A. P. Crary provided new evidence that East and West Antarctica may be separated by a deep ice-filled trough, through the recent discovery of the greatest recorded depth to bottom beneath the Ross Ice Shelf—4400 feet below sea level.

The existence of such a trough (from the Ross Sea to the Weddell Sea) was postulated by Griffith Taylor, geologist with the 1901–1904 Scott Expedition.

Fig. 8. The recording apparatus of a marine magnetometer—an instrument which makes continuous measurements of the earth's magnetic field—aboard the *Vema*, research vessel of the Lamont Geological Observatory. [National Academy of Sciences]

Fig. 9. Seismic explosion on the Byrd station oversnow traverse, made to determine the thickness of the ice. Shock waves from the explosion travel downward to the bedrock and echo to the surface, where they are picked up by receiving equipment. The time required for the waves to reach the bedrock and return indicates the thickness of the ice. The "sno-cat" contains the amplifiers and the recorder. [National Academy of Sciences]

His conclusion was based largely on the division of Antarctica into two distinct segments (East and West) on the basis of geologic and geographic character.

East Antarctica is a vast elevated shield of Pre-Cambrian metamorphic and igneous rocks, overlain by a thick series of flat-lying sedimentary rocks, intruded in places by igneous materials. West Antarctica is characterized primarily by folded ranges and plateaus of metamorphic rock and igneous intrusions similar to those of the Andes. These are also overlain by younger sediments. The existence of this trough is also suggested by the deep penetration into Antarctica of the Ross and Weddell seas.

Further work is in progress during the present antarctic summer to determine whether the trough extends all the way to the deep basin discovered earlier in Marie Byrd Land and from there to the Ross Sea. An IGY Byrd station traverse, led by Charles Bentley, is now en route to the Horlick Mountains, which extend southeastward from the southeast corner of the Ross Ice Shelf; this group is making geophysical studies that are expected to help solve the problem of the trough's existence and exact location. An IGY airborne traverse led by Edward Thiel has launched a series of seismic and gravity measurements in Marie Byrd Land to seek further evidence as to whether the ice-filled basin found there by members of the 1957–1958 Byrd station traverse may be part of the hypothetical trough connecting the Ross and Weddell seas.

Gravity. The IGY program in gravimetry was designed to provide standards for calibration of gravimeters and for international datum control. Four meridional lines were established by the group led by G. P. Woollard of the University of Wisconsin: Alaska to Chile, Greenland to Argentina, Norway to South Africa, and Japan to Antarctica. These measurements were made by means of Gulf compound quartz pendulums. For comparison of possible systematic difference, some of these stations were also measured with the Cambridge compound Invar pendulum.

Gravimeter measurements were made in conjunction with seismic observations (but more frequently than the latter) by the Ellsworth, Byrd, and Little America traverse parties. In addition, the British Trans-Antarctic Expedition, led by Sir Vivian Fuchs, made gravity observations at approximately ten-mile intervals along its entire route (using a gravimeter loaned by Woollard).

The first successful measurements of gravity on the surface of the open sea were made on 22 November 1957, by J. Lamar Worzel of Lamont Geological Observatory, using the recently developed Graf sea gravimeter. This instrument overcomes the principal difficulties previously encountered in making gravity measurements at sea: (i) nonavailability of the submarines that were required for this work and (ii) poor determination of position by a submerged submarine.

The new sea gravimeter was found to have additional advantages over the standard submarine pendulums. Surface gravity measurements made by Worzel from a stabilized platform aboard the *U.S.S. Compass Island* were taken in nine hours, as compared with two days required for earlier submarine measurements of comparable areas. The data were reduced in just one-half day, as compared with two weeks needed to adjust and compute data from the submarine measurements. Two sea gravimeters are now in operation at Lamont. In a relatively short time it will be possible to cover the oceans with an impressive network of gravity profiles.

L. B. Slichter of the University of California (Los Angeles) has directed the United States program for measuring earth tides by special gravimeters sensitive to changes in gravity of one part (or less) per billion. Recordings have been made by two such instruments at 13 sites: Glendora (California), Honolulu, Wake Island, Baguio City (Philippines), Saigon, New Delhi, Bermuda, the Azores, Bukavu and Bunia (Belgian Congo), Trieste, and Winsford and Bidston (England). Each observation requires about 40 days (including ten days for the instrument to settle down after transit). These measurements are made to compare calculated and theoretical tides of semidiurnal and diurnal periods as a function of position on the earth and distance from the ocean. In addition, these data will be searched for the presence of disturbances with a period corresponding to that of free vibrations in the earth—about 55 minutes.

Latitude and longitude. In cooperation with astronomers at the various observatories, special moon-position cameras developed by William Markowitz are in operation under the auspices of the U.S. Naval Observatory at some 20 astronomical observatories around the world. The Markowitz camera takes simultaneous exposures of the moon and surrounding stars, holding the moon's image fixed relative to the stars. Several observations taken on a single night fix the position of that station with reference to the center of the earth and without dependence upon a plumb line. The Markowitz camera is also useful in making determinations of uniform time, the moon performing a function comparable to the minute hand on a clock and the stars acting like the hour hand (*4*).

Synoptic Program

The primary objective of the IGY was the acquisition of data taken simultaneously at various points on the earth in order to give a planetary view of phenomena and events in most of the major fields of geophysics. Both space and time variations were important, and this accounts for the broad geographical coverage and for the 18-month period (1 July 1957–31 December 1958).

World Data Centers. This basic goal of the IGY was reached, for the observational program of the IGY was prosecuted even more effectively than anyone had hoped during the planning period. The evidence for this generalization lies within the three world data centers, established to maintain collections of IGY data. One of these is in the United States, a second is in the U.S.S.R., and a third has subcenters located according to scientific discipline in Australia, Japan, or any one of several nations of western Europe.

World Data Center A comprises subcenters in 11 institutions in the United States. World Data Center B (maintained by the U.S.S.R.) is divided into four subcenters; three of these are in Moscow, while the fourth subcenter, for flare and plage indices, is in the Crimea. World Data Center C has subcenters in eight nations of western Europe and in Australia and Japan, as follows: meteorology (Switzerland), geomagnetism (Denmark, Japan) aurora (Sweden, Great Britain), airglow (France, Japan), ionosphere (Great Britain, Japan), solar activity (Switzerland, Italy, Great Britain, France, the German Federal Republic, Australia), cosmic rays (Sweden, Japan), glaciology (Great Britain), rockets and satellites (Great Britain), seismology (France), gravimetry (Belgium), and nuclear radiation (Sweden, Japan).

The status of data interchange within the IGY may be summarized by examining the data in the 11 subcenters of World Data Center A in the United States. By and large the record is an impressive one, indicating wholehearted cooperation in this as well as in the observational phase of the program.

Airglow and ionospheric physics (Na-

tional Bureau of Standards). After completion of the absolute calibration of IGY airglow photometers in the spring of 1958, data from the first year's observations from many stations reached the data centers. The flow of ionospheric data is immense. Data have been received from each of the other world data centers, and directly from 149 stations in 43 nations. Over 100 miles of ionogram film have been processed. The dispatch to other data centers of data received by center A is fully current. Interim catalogs on airglow and ionosphere were issued by the center in April and July 1958.

Aurora—instrumental observations (University of Alaska). Data from instrumental auroral studies are flowing more slowly than anticipated. More time had been required for processing and reducing all-sky camera films and for transmitting them to the data center than was estimated in the schedule of the Special Committee for the International Geophysical Year (CSAGI). However, data have been received from 33 of the all-sky cameras operated as part of the United States program. Films have also been sent to World Data Center A from Canada, Chile, and the U.S.S.R. Center A is copying and shipping all-sky camera film on a routine basis to centers B and C, and to center A for aurora (visual observations) in support of the mapping program conducted at that center.

Aurora—visual observations (Cornell University). The number of stations from which data are expected, by area, is approximately as follows: United States, 500; Canada, 400; World Data Center B, 400; World Data Center C, 350. Some data have been received from about 1100 of these. The center has IBM cards for visual observations up to October 1958 and hourly (in some instances quarter-hourly) auroral maps, provided through the U.S. Reporter, up to September 1958. The center has also received IBM cards for 1957 from the following U.S. Antarctic stations: Little America, Ellsworth, and South Pole. Data and catalogs of data have been sent to the other world data centers. Data have been received from data center C and directly from Argentina, Canada, Cuba, Hungary, Mexico, New Zealand, and Rumania.

Cosmic rays (University of Minnesota). Data are flowing regularly to data center A from centers B and C. Most stations send data directly to all world data centers. Data have been received at center A from 70 of 111 stations, representing 21 of the 38 nations participating in the IGY cosmic ray program. By October 1958, 12 months of data were due in; of these approximately 43 percent had been received.

Geomagnetism, gravity, and seismology (U.S. Coast and Geodetic Survey). World Data Centers B and C act as collecting institutions and have forwarded some data to center A in that capacity. Data received in World Data Center A are forwarded regularly to the other data centers as required. Geomagnetic data have been received from 115 of 262 sta-

Fig. 10. The Ellsworth station traverse party near peaks of the Dufek Massif in Edith Ronne Land—probably a part of the Pensacola Range. This was the first surface exploration of these mountains, which were discovered from the air in 1956. The "sno-cat" in the foreground has an electronic crevasse detector mounted in front of the hood. [National Academy of Sciences]

Fig. 11. View of the Blue Glacier IGY Glaciological Station and of the Olympic Mountains, Olympic National Park, Washington. Living quarters and laboratory building are in the center of the picture; meteorological instruments, at right. [University of Washington]

tions in 30 of the 49 nations participating in the IGY geomagnetic program.

So far the flow of gravimetric data has been small. Data have been received in World Data Center A from 26 of 230 stations in five of the 18 nations conducting earth tide studies: Argentina, Hungary, Iran, Italy, and Japan. Data have been received from 207 of the 398 stations conducting seismic observations. Bulletins containing seismic data have been sent directly to center A from stations or national collection agencies of 28 of the 52 nations which are participating in the IGY seismological program.

Glaciology (American Geographical Society). Glaciological data from the traverses conducted during the antarctic summer of 1957–1958 have been collected and processed at Ohio State University. The seismology and gravity data from these traverses have been processed at the University of Wisconsin. All of these traverse data are now ready for transmission to the respective data centers. This center has issued the first volume of the "WDC-A Glaciological Report Series." This volume includes preliminary reports received by the center prior to 23 June 1958.

Longitude and latitude (U.S. Naval Observatory). Data from the two programs in longitude and latitude are reaching the appropriate primary data centers; astrolabe data are sent to Paris, moon-position data to Washington. These data will be reduced and published by the primary data centers. The flow of moon-position data commenced late because of delays in starting the observation program. Data for the moon-position program are originally in the form of photographic plates from the 20 moon-position cameras. These plates are sent to one of four measuring centers: Washington, the Cape of Good Hope, Paris, and Herstmonceux. Measurements are sent to the U.S. Naval Observatory for computation and publication.

Meteorology and nuclear radiation (U.S. Weather Bureau). All stations in this discipline send their data either direct to World Data Center C (World Meteorological Organization, Geneva) or to center C via centers A or B. In accordance with CSAGI agreements, center C will reproduce all IGY meteorological data on microcards, which will be available to other interested persons or agencies. The flow of basic data from stations within the United States' area of responsibility is quite prompt. Data have been processed and machine listings have been made and shipped to World Data Center C as follows: synoptic land, through May 1958; synoptic sea through May 1958; radiosondes, through April 1958; and upper winds, through May 1958.

The flow of meteorological data from the various United States stations to World Data Center A, and thence to the World Meteorological Organization, World Data Center C, depends on the communication facilities available and the time required for checking the data and transcribing them to WMO-IGY data forms. Data from stations in Antarctica, for example, come in only once yearly. Several months then are required for checking them and entering them on the WMO-IGY forms. At the same time that data are submitted to the World Meteorological Organization, selected data are also processed at the U.S. Weather Bureau's National Weather Records Center at Asheville, North Carolina, and put on punched cards. The flow of data to center A from the stations in North America alone amounts, on the average, to 25,000 punched cards per day; for the entire world network of stations, at least 100,000 cards per day would be required. The punched cards are most useful in analyzing the data and retrieving specialized information; for general use of scientists throughout the world, World Data Center C is making the data available on microcards.

The pattern for the flow of data on nuclear radiation was established several months after the beginning of IGY. Center A has received data in nuclear radiation from 47 of 420 stations in 11 nations participating in this program.

Oceanography (Agricultural and Mechanical College of Texas). Sea-level and long-wave data from 14 countries have been sent to World Data Center A. Most of the data received so far relate to the less extensive cruises or to cruises conducted prior to the IGY, although data have recently been received from nine major United States and two major U.S.S.R. cruises. Data have been sent to and received from World Data Center B and have also been sent to a permanent service for oceanography, the Liverpool Tidal Institute. Interim catalogs of data were prepared by the center in April and July 1958.

Rockets and satellites (National Academy of Sciences). The section of the "CSAGI Guide" outlining the operation of the data centers for rockets and satellites was issued in April 1958 and revised at the Fifth CSAGI Assembly in Moscow in August 1958. At present, data have been received by World Data Center A from Argentina, Canada, Denmark, France, Germany, Japan, South Africa, the United Kingdom, the United States, and the U.S.S.R.

Because of the nature of rocket and satellite data, the agreed-upon timetable allows 12 months after completion of an experiment before published results are expected. In order to keep the scientific public informed during this period, World Data Center A for rockets and satellites initiated two series of reports containing interim and preliminary observations and results. To date, reports Nos. 1 to 6 of the "WDC-A Satellite Report Series" and No. 1 of the "Rocket Report Series" have been issued.

Solar Activity (High Altitude Observatory, University of Colorado). Data flow very promptly in this discipline. Center A has received data from 24 of the 36 nations participating in the solar-activity program. In addition to the telegraphic data, written and tabulated reports are received regularly and promptly. Monthly lists of solar flares are dispatched by the seventh of the following month.

As part of the intermediate publication of data, this center has published "Reports of Surges and Active Prominence Regions" for the months of July 1957 to March 1958 [reports No. 1–3 of the "WDC-A Solar Activity Report Series"] and "Observations of the Solar Electron Corona" for September 1956 to January 1958 [report No. 4 of the series]. The center published a 12-month catalog of data on 15 July 1958.

The problem of data reduction is clearly a formidable one. Fortunately, information processes, techniques, and devices were available to the IGY, and much of the data, particularly in the fields characterized by large volumes, was reduced as it flowed to the subcenters of World Data Center A. The analyses of reduced data have already begun, but this task of analysis and interpretation will occupy theoretical-minded geophysicists and physicists for many years. Even several decades hence, the body of IGY data will provide a valuable reservoir for research, particularly in the light of the discoveries that will be made in coming years.

Meanwhile, the formal end of the IGY program, on 31 December 1958, does not mean the termination of international cooperation in geophysics. During the Fifth General Assembly of the IGY, in Moscow, it was agreed that during the year 1959 cooperation along the lines of

the IGY would be continued. This program has been given the designation International Geophysical Cooperation—1959 (IGC-59). Such studies as appear practicable to the participating IGY committees will be conducted as part of an internationally coordinated effort, with interchange of data, as in the IGY, under the aegis of the International Council of Scientific Unions. The council has authorized the establishment of a Special Committee for Inter-Union Cooperation in Geophysics (SCG), which will assume responsibilities for IGC-59 similar to those that CSAGI assumed for the IGY. Moreover, those fields that particularly call for extensive and intensive studies are receiving attention. Thus, the council has established special committees dealing with oceanography, the Antarctic, and space science. Counterpart committees have been established in these areas by the National Academy of Sciences, and significant steps have been taken for planning long-range programs in the above three fields, including activities for 1959. In addition, the council has authorized the continuation of the solar patrol and related world communications services which proved so useful during the IGY both in studying solar activity and in alerting scientists everywhere to solar events that were apt to result in terrestrial effects. Finally, the council has endorsed the proposal for a world magnetic survey during a quiet solar period, some four to five years from now.

References and Notes

1. H. Odishaw, "International Geophysical Year (Part I)," *Science* 128, 1599 (1958).
2. The preparation of this summary of IGY is based entirely upon reports and descriptions of projects supplied by the scientists and institutions engaged in the IGY research program. Many of them are mentioned in the text, although in this short summary it has not been possible to refer to all of the scientists who are producing contributions through their IGY programs or to describe all of the IGY accomplishments. The United States IGY program itself has been made possible only through the great contributions of time and effort of so many individual scientists and the participation and cooperation of public and private institutions. Particular acknowledgement should be made to members of the National Academy of Sciences' IGY staff who have assisted in the collection and preparation of the material contained in this article: Pembroke J. Hart and Stanley Ruttenberg.
3. H. Odishaw, "International Geophysical Year: A report on the United States program," *Science* 127, 115 (1958).
4. Data are being accumulated, and the results will appear in the bulletin of the U.S. Naval Observatory.

Engineering Information—All Is Not Lost

Literature is being effectively used despite current lack of efficient mechanical retrieval systems.

Ralph H. Phelps

More or less continually one is confronted with statements to the effect that the recent growth of the scientific and technical literature has been so great that its use is impracticable, if not impossible. In a general sense this idea goes back to the Old Testament of the Bible, which says, "Of making many books there is no end" (*1*). In the 1890's when the Royal Society of London was contemplating the publication of "The International Catalogue of Scientific Literature" (*2*), as well as at various other times, the increasing amount of the literature and the difficulty of its use have been deplored.

Another matter about which much has been said and written since the advent of the sputniks is the extent and excellence of Soviet abstracting services, often with the implication, if not the statement, that abstracting and indexing services in the United States are inferior. I would not minimize the importance of the Soviet abstracting services; they are impressive, if for no other reason than because they have grown so rapidly since they were started in 1952. Also, because the work is centralized and many literature scientists work in one place, it is physically an impressive operation. In this country, abstracting and indexing services are generally not governmental operations and are scattered throughout the country.

If the Soviets have profited more than we have from the technical literature, I believe it is because they may have worked harder at using it. The Soviet centralized information services are not essentially better than the services available in this country. Some of the larger sections of the Soviet abstracting services have no subject indexes and are therefore very difficult to use. Incidentally, in 1957 the Soviets purchased 54 copies of the 1956 bound volume of the *Engineering Index*, which is published in the United States.

Mechanization

Mechanization is currently being studied as a means of reducing the time and cost of the handling and retrieval of literature. For small collections of literature in restricted subject fields, mechanization has sometimes proved satisfactory. For large collections in broad fields covering diverse subject material, including concepts as well as materials, mechanization is apparently many years away. Its current status and some of its many problems and difficulties have been pointed out by Warheit (*3*), Taube (*4*), Shaw (*5*), and Rabinow (*6*). The overall problems of getting the information ready for the machine and getting it from the machine are perhaps greater than those of developing the machine. Machines work best on repetitive and routine operations. Such operations are not common in literature handling and retrieval.

Like many others, I wish that the literature could be searched more quickly and at less cost. I wish that efficient mechanized systems for large collections were now available, but they are not—not even at the very high prices charged for the large computers which are now

The author is director of the Engineering Societies Library, New York. This article is based on a paper presented at the annual meeting of the American Society of Mechanical Engineers, 1–5 Dec. 1958, in New York.

being promoted for literature search work, despite the fact that they were designed for other work and are not particularly efficient as literature-searching tools (*4*).

Despite all of the foregoing, the technical literature can be, and is being, effectively used. Our present abstracting and indexing systems are not as bad as they are made out to be—not nearly that bad. While they may not all be as up-to-date as their publishers or users wish them to be, none of the many abstracting and indexing services available in the Engineering Societies Library is *even close* to being 6, 7 or 8 years behind, as such services were said to be by a witness at a recent Senate committee hearing (*7*).

The same witness also gave the impression that literature searches generally take a great amount of time (he mentioned six months as one example) and that searches cost from $1000 to $100,000 and even more. He also stated that "the little man is out." The Engineering Societies Library makes many literature searches each year for from under $100 to under $1000. These are not complete literature searches, and they may not deal with the largest and the most complex problems, but how often does "the little man" or anyone else deal with these? Letters of commendation and additional orders from those who have used the services of the Engineering Societies Library attest to the value of these inexpensive literature searches.

Up to 31 July 1958, income from the services of both the Engineering Societies Library and the Engineering Index, Inc., had increased over that of the same period last year—this despite the 1958 recession.

Through the activities of the Engineering Societies Library and the Engineering Index, Inc., engineers have a unique documentation center and coordinated services unmatched elsewhere in the world.

Engineering Societies Library

The Engineering Societies Library (now located in the Engineering Societies Building, 29 West 39th Street, New York) was established in 1913 through the merging of the long-established libraries of the American Society of Civil Engineers, the American Institute of Mining, Metallurgical and Petroleum Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers.

The Engineering Societies Library is outstanding in its coverage of the fields of civil, electrical, mechanical, mining, metallurgical, and petroleum engineering. It also extensively covers chemical engineering and all other branches of engineering, primarily on the level of the graduate and practicing engineer. The library contains over 175,000 volumes, 20,000 maps, 5000 translations, and 10,000 bibliographies and indexes. Some 1500 periodicals are currently received from all parts of the world; about one-third of these are in foreign languages. The coverage of Russian and other Eastern European scientific and technical publications has been considerably expanded recently, and important publications are continually added.

In addition to collecting extensively, but selectively, engineering publications of all types on a world-wide basis, the Engineering Societies Library maintains extraordinarily complete files of all technical publications and papers of the American Society of Mechanical Engineers and of the other founder societies. Its collection of these unpublished papers is particularly important, for most of them are manuscript copies not elsewhere available, not even in the societies' own files. The library has special card indexes to some sets of the societies' publications. It also, in some instances, cooperates with the editorial staffs of the founder societies in the preparation of published indexes.

After preprint and published stocks of their publications are exhausted, the founder societies refer inquirers to the Engineering Societies Library for photoprint or microfilm copies. Often this is done simply by transferring the inquirer's letter or order directly to the library. Sometimes the inquirer may be temporarily confused by receiving a reply from the library rather than from the organization addressed, despite the care that is taken by the library to identify the parties involved. Nevertheless, it is felt that the practice of direct transfer of requests is the best way to serve with the least possible delay.

Each issue of *Mechanical Engineering* contains a list of "Books received in the library." These are some of the more than 600 brief book reviews prepared during each recent year for the journal of the founder societies, so that members may learn about new books in their field. Most of these books, as well as others in the library, may be borrowed by members of the American Society of Mechanical Engineers and the other founder societies.

The services of the Engineering Societies Library also include a reading room open six days and five nights a week for most of the year. It is staffed by persons having library and technical training.

Thousands of requests from members for brief information which can readily be located are answered without a charge. For members and others requiring extensive information, literature searches and bibliographies are made, for a fee, to the specific requirements of the inquirer. The service ranges from recommending some books on a specific subject to the preparation of comprehensive annotated bibliographies of books, articles, and reports. Searches are also made for disclosures related to patents. All search work is kept confidential. The library's staff also prepares bibliographies on subjects of general engineering interest. These may be purchased by anyone. A list is available on request.

Translations of engineering and technical articles are made from all languages into good English by "consultant" translators who are familiar with engineering. All translations are reviewed by a member of the staff of the library to assure accuracy of translation and the quality of the English.

Photoprint and microfilm copies of the material in the library are made on request.

All of the afore-mentioned services, except loans of books to members, are available to anyone. They are used by engineers, scientists, technologists, and industry in this country and throughout the world. More than half of the users of the Engineering Societies Library do not come to the library but use its services by mail, telephone, and telegraph.

Joint ownership and support of the Engineering Societies Library by the founder societies is achieved through the United Engineering Trustees, Inc., an organization established by the founder societies to own and operate the Engineering Societies building. The Engineering Societies Library is a department of the United Engineering Trustees, Inc., as is also the Engineering Foundation.

Engineering Index

The *Engineering Index,* now in its 74th year, is an internationally accepted digest of technological literature prepared for engineers, research workers, and students. The Engineering Index, Inc., and the Engineering Societies Library, although separate organizations,

cooperate closely. All publications received by the Engineering Societies Library are made available to the Engineering Index, Inc., which is housed in the same building. In the *Engineering Index* the Engineering Societies Library has a ready-made published index to articles in periodicals and other publications in the library. This unique arrangement is of great value to engineers and industry.

The *Engineering Index* reviews 1400 leading periodicals and society transactions, as well as a substantial number of bulletins and reports of government bureaus, research laboratories, technological institutes and colleges, and other agencies. Last year it provided annotated references to 27,000 articles. It provides a weekly card service in 255 subject divisions. Subscriptions may be placed for single subject divisions, for groups of divisions, or for the entire card service. The cost of the divisions ranges from $12 to $45 each, with a total cost of $1500 for the complete card service. Educational institutions receive a discount. The *Index* subsequently appears as a bound volume, cumulating all of the references for the year. The charge for this bound volume is $70.

This is an up-to-date indexing service, complete with descriptive annotations of the material indexed. Inasmuch as all indexed material is retained by the Engineering Societies Library, there need be no question about where to find the original of any articles indexed in the *Engineering Index*. The articles may be read at the Engineering Societies Library, which is open to anyone, or a photoprint or microfilm copy may be ordered.

In looking to the future, it appears that the cooperative information activities of the engineering societies, the library, and the *Index* will continue to grow. The American Institute of Chemical Engineers has recently become the fifth founder society. The United Engineering Trustees have acquired land for a new building near the United Nations in New York City. It is expected that other societies will join in the support of the Engineering Societies Library when the engineering societies move into the new United Engineering Center. The better facilities to be provided and the broader base of support and interest should lead to expanded and better information services for the engineering profession.

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Bergen Davis, Experimental Physicist

Few of the many acquaintances of Bergen Davis, who died on 30 June 1958, ever realized the continual fight for health which he had to make, almost from the time of his birth in 1869. Too sickly to attend school regularly, he would have acquired a limited and haphazard education if, along with unusual will power, he had not also possessed a great fondness for reading. His remarkable memory for what he had read and observed, and a native curiosity to know what made things go, both served him in organizing his efforts to acquire a suitable education.

He was born near Whitehouse, New Jersey, on the farm which his Holland-Dutch ancestors had acquired from the Carteret grant in the 1730's. As a boy he was too frail to do more than the lightest of farm work. He attended a nearby district school, which contained the county library—for him a most fortunate arrangement.

During his teens he was compelled to be inactive while he strove to conquer tuberculosis. In this period he had access to good books, which he read so thoroughly that he thereby gained much that today is considered the basis of a liberal education. Few scientists of his day were as familiar as he was with the authoritative scientific articles in the family encyclopedia; even fewer maintained throughout life so wide and thorough a knowledge of Shakespeare and Gibbon.

The adequacy of his reading is shown by the fact that by 1891 he was able to enter Rutgers College, from which he graduated in 1896, after losing a year because he had to teach school to obtain funds to finish. His first position was with the School for the Deaf in New York City, where he taught a class of teen-age boys. However, his leisure time was spent in the physics laboratory of Columbia University, where he won the favorable attention of Ogden N. Rood and R. S. Woodward. This led to a fellowship at Columbia, where his dissertation on sound waves brought him a Ph.D. in 1901. The Tyndall Fellowship enabled him to study abroad for two years, first at Göttingen and then under J. J. Thomson in the Cavendish Laboratory in Cambridge. The second year was especially stimulating, for it was spent in the company of an unusual group of scholars, Rutherford among them.

Davis returned to Columbia in 1903, initiating a new era in research in physics there. The laboratory in which he worked was referred to by the graduate students as "the little Cavendish." Here he began his investigations on electrical discharges *in vacuo*, a field which naturally led to the series of papers on x-rays which distinguished his career. His studies of the energy in the x-ray spectrum and his development of the double x-ray spectrometer were outstanding achievements.

Yet his entire academic life, from the time he entered college until his retirement from his Columbia professorship, was interrupted at numerous intervals by the need to fight disease and regain strength. That he was able to win many honors, among them the chairmanship of Section B of the American Association for the Advancement of Science in 1932, the award of the medal of the Research Corporation in 1929, and election

to the National Academy of Sciences, also in 1929, indicates something of the fiber of the man.

Perhaps his determination to overcome obstacles would not have been so effective if he had not had another trait of great importance to a scholar, particularly to one interested in experimental physics. His imagination was very active, so lively that he often felt that it should be held in check. He had acquired by himself the usual mathematical equipment, through the calculus, but he frequently wished that his training in analysis had been more extended. However, his innate curiosity and his own way of looking at things made up to a considerable degree for any deficiency.

He may have been impatient at times, even abrupt on occasion, yet students and friends found him generous and stimulating. With all his cares, Bergen Davis nevertheless showed a ready sense of humor and a passion for freedom of thought.

H. W. FARWELL

Noroton, Connecticut

News of Science

Visiting Research Scientist Program Brings Top Foreign Postdoctoral Scientists to U.S.

Approximately 150 young foreign scientists, all drawn from the highest levels of scientific activity in their respective countries, have begun arriving in the United States for periods of study ranging from 1 to 2 years. The visiting researchers, who come to this country under a program initiated and funded by the International Cooperation Administration, are placed in the proper university and government laboratories by the National Academy of Sciences, which administers the program.

As originally conceived in 1953, the Visiting Research Scientist Program was restricted to the 14 European countries which were members of the Organization for European Economic Cooperation. At that time the program was also viewed as a temporary one, designed to facilitate the flow of scientific and technological information between the United States and the OEEC member countries.

Continuation and Expansion

At the time that the original program, with its limited geographical and temporal ranges, was drawing to an end, the post of director of the International Cooperation Administration was assumed by James H. Smith, Jr., a former assistant secretary of Navy. Smith, feeling that the program, which had been well received in Europe, should not be ended, asked the president of the National Academy of Sciences, Detlev W. Bronk, to consider its continuation and expansion. In making this decision the ICA director had in mind the need to offset the stress put on the purely military applications of science and technology by the accomplishments of the Russian satellite program, the need to improve communication and cooperation between American and foreign scientists, and the need of this country's scientists for the particular abilities and knowledge of many foreign researchers.

Role of the Academy

After the decision to continue and expand the Visiting Research Scientist Program, the National Academy of Sciences, through its Office of Scientific Personnel, began the work necessary to its administration. The original European program had had as a basic policy an arrangement whereby the selection of candidates rested entirely in the hands of the major scientific body, whether academy of science, research council, or the equivalent, in each of the 14 countries concerned. The memberships of these groups would nominate candidates of high qualification that were known to them as the best young scientific talent their country could call upon. These candidates were then accepted by the National Academy of Sciences in a number commensurate with the funds available from ICA. Almost all nominees who could, on practical grounds, avail themselves of the opportunity did in fact come to this country. This equation of the number of nominees to the number of grants reflects the fact that there is no plethora of researchers with the high qualifications required by the program.

The selection policy used in the original phase of the program has been maintained in the new phase. But, whereas the European countries all had an established scientific body which could administer the nomination process, many of the nations in the expanded program, which now includes approximately 44 separate states, did not have such well defined scientific associations. To solve this problem five members of the academy made numerous trips to arrange for local sponsorship of the program. Where no established organization was available, arrangements were made with the universities to nominate qualified persons. Again, as in Europe, the program was well received, and the men and women now arriving in this country are evidence of its success.

Students

To date, since the inception of the program in 1954, about 225 foreign students have studied in the United States. To this number, the 150 now arriving must be added. Their main common characteristic, which was essential to their selection by their respective nominating groups, is their demonstrated ability to carry on their own research projects. They come from the universities, the government scientific facilities, and in a few cases the industrial laboratories of their home countries. Almost all of them have an assured position to which they can return after their study period here. Although the program was primarily set up with a 1-year duration for each grant, most of the grantees avail themselves of the 1-year extension possibility that is offered. By the fact that almost every nominee has received his doctorate before coming to this country, and has, therefore, most usually, acquired a working knowledge of one or two foreign languages, language difficulties are not a major problem. In addition to the initial help and orientation they receive from the members of the academy's staff, the visiting researchers can count on the general hospitality of the Americans they encounter and the particular help and friendship of their colleagues at the universities and laboratories in which they do their research.

The grant from the ICA covers travel expenses for the nominee and his family, and gives a per diem allowance of $10.50, with an additional $1 per day allowed for each member of the family. The research projects undertaken are of such a nature that they do not follow the normal academic year but rather constitute a full year's or two years' work.

Function and Future

M. H. Trytten, director of the academy's Office of Scientific Personnel, has written on the function and future of the program: "Originally the program was deemed to be desirable as a contribution to the European area by acquainting young scientists with American practice in the relationship between academic and industrial research. While the program no doubt contributed to this objective, other worthwhile objectives have been attained which seem of considerable importance in respect to the worldwide program.

"The strengthening of the scientific activities of the free world is important per se. Intimate relationships between American scientists and the leading scientists of the future in these many countries can be of great significance. As before these young scientists contribute much to American science while guests in American laboratories. Finally, the direct cooperation between the organizations of scientists abroad and the Academy-Research Council offers a means of strengthening relationships which could lead to other fruitful cooperative activities. Aside from these benefits, there is the deeper question of the responsibility the nations leading in scientific competence have to assist in the development of indigenous scientific movements in nations less advanced. The burning desire for self-betterment and improved conditions which is so evident in these countries finds its focus in most instances in an urge to improve education and in particular to improve technology. Consequently it would appear to be of major importance to assist in strengthening the educational programs with special emphasis on scientific education. The needs are, of course, great. Not only is assistance needed in the basic sciences, but in the fields of public health, sanitation, natural resources, conservation, and in applied science for industry. The latent human resources in most of these countries are enormous.

"No firm plans for continuation of this program have been made as yet, since continued support by ICA depends on the budget support available. However, there seems to be continued enthusiasm for this type of program, and it would seem probable that a continued effort of this kind would be supported."

Soviet Research Ship Visits U.S.

The first visit of a Soviet scientific vessel to the continental United States during the International Geophysical Year occurred on 17 December, when the *Vityaz* arrived at San Francisco. Representatives of the National Academy of Sciences greeted the Soviet scientists and crew, who have been engaged in oceanographic studies in the Pacific as part of the IGY program.

During its IGY voyages, the *Vityaz* sounded a record depth in the Pacific of 35,948 feet, off the Philippines in August 1957; discovered a 20,340-foot depression in the ocean floor north of the New Hebrides Islands; and brought to the surface from depths of 35,000 feet several previously unknown species of sea animals.

Scientists who visited the ship when it docked at Vancouver, B.C., in November report that it is extremely well equipped for a variety of oceanographic work. Approximately 65 scientists and a crew of about the same number are on board, including about 35 women. Chief of its scientific party is Nikolai Sysoev, whom many U.S. scientists met in Moscow last August at the Fifth General Assembly of the World IGY Committee.

The Soviet Government indicated in advance that the *Vityaz* would be open to visit by American scientists and other interested persons while she was in San Francisco, and later in Honlulu, and that arrangements for such visits should be made with the ship's authorities after her arrival. The National Academy of Sciences' IGY Committee asked John Lyman, a member of the US–IGY Committee's panel on oceanography, to make arrangements for these visits and for visits by the Soviet scientists to American scientific research facilities and institutions. Scientists from the University of California at Berkeley, the Scripps Institution of Oceanography at La Jolla, the U.S. Navy Hydrographic Office, the U.S. Coast and Geodetic Survey, and representatives of other interested institutions went on board the vessel.

The *Vityaz* is one of 13 Soviet ships participating in the IGY oceanography program, nine of them being primarily research vessels. Including the U.S.S.R., 25 nations are engaged in IGY oceanographic work, using a total of approximately 70 vessels. Of these, United States institutions account for eight.

Technical Translations

The Department of Commerce will begin publication this month of a periodical planned to serve as a central source of information in the United States on Russian and other technical translations available to science and industry. The periodical, *Technical Translations*, will be published twice a month by the Office of Technical Services, in cooperation with the Special Libraries Association. It will list and abstract translated material available from U.S. Government sources, SLA, cooperating foreign governments, educational institutions, and private sources. The Special Libraries Association's *Translation Monthly*, familiar to all who have been working with translations, will be incorporated in *Technical Translations*.

Most of the foreign material that OTS is collecting from government agencies has not been previously available to the public, and the volume from this source alone is expected to run as high as 10,000 complete translations a year. Abstracts of this material will begin appearing in the new journal immediately. *Technical Translations* will will be sold by OTS at $12 a year ($4 additional for foreign mailing); single copy, 60 cents. Orders should be addressed to OTS, U.S. Department of Commerce, Washington 25, D.C.

Resources for the Future

Resources for the Future, which has headquarters at 1145 19th St., NW, Washington, D.C., has planned a forum, a series of six lectures and discussions that will deal with new developments in the natural sciences and in technology, and with their impact upon society and resources. Each lecture, given by a natural scientist noted in his field, will be followed by a discussion by leaders in the social sciences, business, or politics; these participants will relate scientific developments to their long-term social and economic significance. The forum series will be held in the Smithsonian Institution's Museum of Natural History. The program follows:

8 January: Genetics. George Beadle, chairman, Division of Biology, California Institute of Technology, and 1958 Nobel Prize winner; Henry A. Wallace, plant breeder, formerly Vice President of the United States, Secretary of Agriculture, and Secretary of Commerce; O. V. Wells, economist, administrator, Agricultural Marketing Service, U.S. Department of Agriculture.

22 January: Weather Modification. Horace R. Byers, chairman, department of meteorology, University of Chicago; Clinton P. Anderson, U.S. Senator from New Mexico, formerly Secretary of Agriculture; Edward A. Ackerman, geographer, assistant executive officer, Carnegie Institution of Washington.

5 February: Mineral Exploration. John A. S. Adams, associate professor of geochemistry, Rice Institute; Paul W. McGann, chief economist, U.S. Bureau of Mines; another speaker to be announced.

26 February: Chemical Technology. Earl P. Stevenson, industrial chemist, chairman of the board, Arthur D. Little, Inc.; Richard L. Meier, organic chemist, research associate in planning, University of Michigan; Frederick T. Moore,

economics division, Rand Corporation.

5 March: Nuclear Energy. W. F. Libby, physical chemist, member, U.S. Atomic Energy Commission; E. Blythe Stason, dean of the Law School, University of Michigan; Philip Mullenbach, economist, director of research on nuclear energy study, Twentieth Century Fund.

12 March: Outer Space. Lee A. DuBridge, physicist, president, California Institute of Technology; Alan L. Dean, political scientist, management analyst, U.S. Bureau of the Budget; another speaker to be announced.

Journal in Microform

An experiment in the publication of a scientific journal exclusively in microform is to be conducted during the next 3 years by the American Institute of Biological Sciences, Washington, D. C., with the assistance of grants from the Council on Library Resources of Washington, D.C., and the National Science Foundation. The journal which will be the subject of the experiment is *Wildlife Disease*. It is the publication of the Wildlife Disease Association, an international organization with a current membership of approximately 300, concerned with the parasites, diseases, physiology and other factors relating to the health and survival of wild animals, both in nature and captivity, and with the indirect relations of such factors to domestic animals and man. The journal will commence publication as a quarterly in January 1959.

The purpose of the experiment is to explore a number of unknowns with respect to the application of the microtext techniques to the publication of the results of research: (i) whether a small specialist group, unable to support the cost of a journal in letterpress, can do so with the use of microform; (ii) whether a journal in microform will serve the purpose of scientific communication in terms of author, reader, and library reaction; (iii) whether use of this technique will assist in expediting the publication of the results of research; (iv) whether—by reducing the cost of publication—this form of publication will require less abridgement of important data than has become necessary with scientific journals generally; (v) whether the technique of photographic reproduction which will be employed will lend itself to superior presentation of photographic data over half-tone reproduction; and (vi) what optima can be found in terms of microtext medium, page-size and arrangement, and other details of format and so forth.

The journal will be published on 5- by 3-inch Microcards to be manufactured and supplied by the Microcard Corporation of West Salem, Wis. Each quarterly issue will comprise approximately four cards. Each card will contain a single article of up to 47 pages in microtext, but will bear in full-size type the citation of author, title, and issue-number. A leaflet that contains abstracts of the articles in full-size type will accompany each issue. These abstracts will be reported to *Biological Abstracts*.

Optical devices will be needed to read the microscopic print in which the journal is printed. Nonportable reading devices for this purpose are familiar objects in libraries, but few individuals can afford to own them. Consequently, one of the objectives of the experiment will be to test the applicability for this purpose of a small portable, but also inexpensive, hand-viewer. Such a viewer will be provided to the original members of the association at a nominal charge and will be available to later members at a cost expected to be less than $10. Also, although the experiment is to be conducted initially with Microcards, it is anticipated that other forms of microtext may later be compared.

In order to explore the impact of this form of journal publication on libraries, the association has arranged that Foster E. Mohrhardt, librarian of the U.S. Department of Agriculture, be associated with the experiment to observe and report on this impact.

The co-editors of the journal are Carlton M. Herman, chief, Section on Wildlife Diseases, U.S. Fish and Wildlife Service, Laurel, Md.; and David E. Davis, professor, Johns Hopkins University School of Hygiene and Public Health, Baltimore, Md. The business offices of the association are at the headquarters of the American Institute of Biological Sciences, 2000 P St., NW, Washington 6, D.C. Membership in the association, which carries with it a subscription to the journal and an irregularly issued Newsletter, is $1 per year.

Hunter Laboratory of Psychology

The Walter S. Hunter Laboratory of Psychology was dedicated on 1 November at Brown University, where the late Professor Hunter was chairman of the psychology department from 1936 to 1954. During the ceremony, honorary degrees were conferred on Clarence H. Graham of Columbia University, Joseph McVicker Hunt of the University of Illinois, Donald B. Lindsley of the University of California, Los Angeles, and Nils Y. Wessell, president of Tufts University.

The dedication took place in the laboratory's auditorium, which has been named after Leonard Carmichael, secretary of the Smithsonian Institution, who was the principal speaker. Carmichael, a former chairman of psychology at Brown, said of Hunter: "Hunter became one of the leading exponents of an enlightened objective and behavioristic psychology that has now come to be almost synonymous with scientific psychology in this country."

To conclude the ceremony, Harold Schlosberg, present chairman of the department, expressed thanks for the building, which he described as being "anything and everything a psychologist could ask for."

Electronic Calibration Center

The Electronic Calibration Center of the National Bureau of Standards was formally dedicated at the bureau's Boulder, Colo., laboratories in mid-August. Housed in a new wing of the Radio Standards Laboratory, the center provides Government, industry, and the military services with access to the nation's primary electronic standards.

The chief mission of the new center is to calibrate interlaboratory standards for such quantities as voltage, power, and impedance in terms of the national standards maintained by NBS. These interlaboratory standards, in turn, are used to assure the accuracy of reference and working standards in laboratories, on the production line, and in overhaul stations throughout the nation.

The quantity of electronic calibrations required today in the design, manufacture, and adjustment of extremely complex electronic weapons, communications equipment, and industrial electronic apparatus is so great that branching chains of measurement are necessary to extend the national standards to the shop or field instruments used for this work. The large number of links in each chain, through which the units of measurement must be transferred, requires the highest practicable accuracy at each step in order to assure adequate accuracy of the shop and field instruments.

The fundamental system of electrical measurement now employed in the United States uses absolute units, that is, units derived from the fundamental units of length, mass, and time—the meter, kilogram, and second. Basic to the absolute system of electrical units are the absolute ohm and the absolute ampere. The absolute ohm is derived from the absolute henry, based on an inductor of accurately known dimensions. The absolute ampere is established in terms of the magnetic force on an accurately dimensioned current-carrying coil, measured with a current balance. These basic standards are maintained in the NBS laboratories in Washington, D.C.

Other units, such as the watt and the

kilowatt hour, are obtained by combining these units and by extending the scale of measurement. The units then are transferred to higher frequencies by appropriate techniques.

Services offered by the Calibration Center cover three broad frequency ranges: (i) low-frequency (zero frequency through about 30 kc); (ii) high-frequency (30 kc through about 300 Mc); and (iii) microwave (above 300 Mc).

Somewhat more than half of the initial instrumentation program has been completed, and the center now is able to provide the most urgently needed services. Additional standards and instrumentation, beyond the present program, will be required in the future to replace those made obsolete by technological advances and to extend the capabilities of the center as new calibration requirements arise. The eventual goal is to measure and standardize in the center all electronic quantities for which there is a substantial calibration need. Calibrations required only infrequently may often be obtained elsewhere in the bureau.

The importance of proper environment for precision measurement operations is widely recognized. A well-lighted area that is free of mechanical vibration and shielded against radio and other electrical interference, that has regulated and well-filtered power lines and dust-free air of controlled temperature and humidity is essential to calibration work where the primary standards are concerned. All of these features have been incorporated into the new center. In addition, nearly all of the electrical equipment has been installed in consoles, for the convenience of the operating personnel and for the protection of the sensitive equipment. Incorporating all the latest technological advances, this laboratory could well serve as a model for standardizing laboratories throughout the world.

Artificial Insemination

A new method for preserving and shipping bull semen that promises to cut operating of artificial insemination programs has been reported by O. T. Stalcup of the University of Arkansas Agricultural Experiment Station. The method, which is the result of a 2-year research program, reduces the number of collections and cuts shipping costs in half.

Basic principles of the process involve adding carbon dioxide and glycine to an extender composed of egg yolk, distilled water, antibiotics, and other ingredients. Carbon dioxide keeps the spermatozoa alive in the absence of free oxygen. Glycine is an amino acid containing protein that protects and nourishes the spermatozoa. Another chemical, glutathione, is added to activate the spermatozoa when ready for use, thus increasing the period of time they can be stored successfully. Field trials indicate that semen processed and shipped with this extender can be safely used for 3 to 4 days, compared with 2 days for present extenders.

Grants, Fellowships, and Awards

Fluid mechanics. A $3000 Boris A. Bakhmeteff research fellowship will be available for the 1959–60 academic year to support a research project of an original and creative nature in the general field of mechanics of fluids. The recipient must be a full-time graduate student who is a candidate for the master's or doctoral degree. He may not hold any other fellowship or major income-producing commitment that will interfere with his research work and study on a full-time basis. The study and research may be undertaken at an institution of the fellow's choice. Applications must be filed by *15 February 1959*. Forms may be obtained from: Dean William Allan, School of Technology, City College of New York, New York 31, N.Y.

General, for women. Sigma Delta Epsilon, graduate women's scientific fraternity, has announced its predoctoral fellowship for 1959–60. These fellowships are awarded to women who give evidence of ability in scientific research, and who need financial assistance to further a well-defined project contributing to the Ph.D. or equivalent degree. Candidates should be graduate students in the physical, biological, or mathematical sciences who during the fellowship tenure will be devoting more than half time to a thesis or to thesis research. The stipend is $1600. Application forms, which must be returned by *1 February 1959*, may be secured from: Dr. Geneva Sayre, Department of Biology, Russell Sage College, Troy, N.Y.

Parasitology. The American Society of Parasitologists has announced that it will confer annually, or less often, an award for meritorious research in parasitology. The award, sponsored by Parke, Davis & Company, will consist of a check for $1000, a medal, and a $150 travel allowance for the recipient. The new prize has been named in honor of Henry Baldwin Ward, who founded the society's *Journal of Parasitology* and served as the society's first president. Members of the society whose accomplishment occurs within 15 years after the completion of academic training are eligible for the award.

Psychiatry. The Hofheimer Prize of $1500 is awarded annually by the American Psychiatric Association for an outstanding research contribution in the field of psychiatry or mental hygiene which has been published within a 3-year period up to the date of the award. It is imperative that contributions submitted for consideration be published, since studies in press or in preparation are not eligible. This competition is open to citizens of the United States and Canada who are 40 years of age or under at the time the study was submitted for publication; or to a research group whose median age does not exceed 40 years.

The next award will be made at the annual meeting of the association in April of 1959. Eight reprints or duplicated copies of each entry, as well as the necessary data concerning age and citizenship, must be sent *by 15 February* to John I. Nurnberger, M.D., Chairman, Hofheimer Prize Board, 1100 West Michigan St., Indianapolis 7, Ind.

News Briefs

The American Association of University Professors has announced receipt of a grant of $10,000 from the Fund for the Republic. This money will go into the association's Academic Freedom Fund. It will be used to help teachers who have been discharged or suspended without pay in clear violation of academic freedom. Assistance will also be given the faculty of a college or university where a general crisis threatens freedom in education.

* * *

Two Congressional subcommittees announced on 7 December that they had started an investigation of whether "bottlenecks and red tape" in the Atomic Energy Commission were holding back the nation's nuclear programs. The chairmen of the subcommittees, representatives Melvin Price, Democrat of Illinois, and Chet Holifield, Democrat of California, said that the Joint Atomic Energy Committee had become "increasingly aware of delays in contract negotiations and delays in acting on requests by the joint committee and the Congress."

* * *

When Project Vanguard was transferred from the Navy to the National Aeronautics and Space Agency on 1 October, NASA gave to the 150 members of the Vanguard staff the option of transferring to the new agency or remaining at NRL. Most of them have elected to go with the project. NASA is in full operation administratively, but as yet it has no laboratory quarters. For probably a year or more, Hagen and his associates will remain where they are, either at NRL or at Cape Canaveral and the various tracking stations. But henceforth

they will be directed by NASA and will be paid from NASA funds.

* * *

The Soviet Union has given Poland one of its Antarctic research bases and thus raised to 13 the number of nations active in Antarctica or its islands. Polish scientists are said to be preparing to sail south on the Soviet ship *Mikhail Kalinin* with the regular Soviet expedition. The Poles will take charge of Station Oasis, so-called because it is located on Bunger Oasis, a part of the subcontinent not covered by ice. The Oasis is about 225 miles east of Mirny, the main Soviet base, and about half way between Mirny and Wilkes Station, the nearest United States base.

* * *

The new U.S. Department of Agriculture Fruit and Vegetable Products Laboratory at Winter Haven, Fla., was dedicated on 4 December. The laboratory, part of USDA's Southern Utilization Research and Development Division, conducts research to extend the utilization of fruits (principally citrus and other subtropical fruits) and vegetables.

Scientists in the News

VITTORINO VERONESE of Italy is the new director of the United Nations Educational, Scientific and Cultural Organization. He succeeded LUTHER EVANS of the United States on 5 December in the closing ceremony of UNESCO's tenth general conference, which began 4 November in the new headquarters building on Paris' Left Bank.

Veronese, considered by many as a European intellectual who will reduce the emphasis placed in the past by Evans on technical assistance programs for underdeveloped nations, sought in his inaugural address to reassure the smaller nations.

"Assistance to scientific and cultural cooperation is not to the prejudice of technical assistance, but, on the contrary, lends it impetus. . . . It is one of UNESCO's main duties to convince specialists that their reseach work must have a bearing on technical assistance, even when it is not directly associated with it.

"Similarly, the recipients of technical assistance must come to understand that it is, in fact, in the laboratories, institutes, universities and scientific congresses that the techniques subsequently handed on to them are worked out.

"What I want is not a balance between these two trends, but continuous, spontaneous cooperation."

Veronese practiced law for 10 years before he moved into the social and educational fields. He is a zealous Roman Catholic, the former president of the Italian Catholic Action and a tireless worker in Italian and international Catholic activities. Veronese's association with UNESCO began in 1948, the same year that Italy became a member of the organization. He has attended every general session since then as a member of the Italian delegation. Since 1952 he has been a member of UNESCO's executive board, of which he was chairman from 1956 until his nomination as secretary general by the board last September.

BRUNO PONTECORVO, the Italian-born physicist who left Britain for the U.S.S.R., has been nominated for a Lenin Prize in science, highest Soviet decoration in the field. Pontecorvo disappeared behind the Iron Curtain in 1950, after having worked 7 years on secret British nuclear research projects. He has since taken out Soviet citizenship. Other Soviet scientists nominated for the Lenin Prize follow.

V. I. VEKSLER and others were cited for construction of a 10-billion-electron-volt synchrophasotron, believed to be the world's largest atomic particle accelerator.

L. D. LANDAU, author of nuclear physics textbooks that have been translated into English, was cited for research on "conversion laws at weak interactions" and "polarization properties of the neutrino." Landau was one of the scientists behind the launching of the Soviet earth satellites.

V. A. FOK, theoretical physicist, was cited for a new "theory of space, time and gravitation."

J. L. GINSBURG and I. SHKLOVSKY were cited for their "theory of cosmic radiation and origin of cosmic rays." This theory is that cosmic rays result from flare-up of super-novas and new stars.

N. G. BASOV and A. M. PROKHOROV were cited for their "discovery and development of a new principle in the generation and amplification of radio waves, resulting in the creation of molecular amplifiers and generators." Such amplifiers are used as high-precision measuring instruments.

S. I. BABKIN and nine associates were cited for designing a "Sewing machine" for use in blood-vessel surgery.

ROGER ADAMS, professor emeritus at the University of Illinois and an internationally known organic chemist, received the American Chemical Society's Charles Lathrop Parsons Award, for outstanding public service, at a dinner in Washington, D.C. on 6 December. Adams is a former president of the AAAS, as well as of the ACS, and a former chairman of the ACS board. He is a member of the board of directors of the National Science Foundation and the board of trustees of the Sloan–Kettering Institute for Cancer Research.

The Parsons award, which cannot be given more frequently than once every 3 years, consists of a scroll and the privilege of choosing the recipient of a $2000 scholarship for graduate study in chemistry, chemical engineering, or some related field.

A second feature of the Washington dinner was the presentation of a special ACS membership pin to E. J. CRANE of Columbus, Ohio, for long and outstanding service to the society. Crane, former director of the Chemical Abstracts Service and former editor of *Chemical Abstracts,* retired in November after 47 years with the American Chemical Society publication.

R. CHARLIER, head of the pharmacology department in the Research Division of LABAZ Laboratories, Brussels, Belgium, received the prize of the Belgian Society of Cardiology on 19 September during the third World Congress of Cardiology, which was held in Brussels. He was honored for his paper entitled "Un nouveau coronarodilatateur. Etude pharmacologique." The prize was 100,000 Belgian francs.

EDGAR C. BAIN, retired vice president in charge of research and technology of the United States Steel Corporation, has received the Ambrose Monell Medal for distinguished achievement in mineral technology. Bain, an internationally known metallurgist, is responsible for establishing the scientific basis of heat treating steel, and was one of the first scientists to use x-ray diffraction techniques in the systematic study of alloys. The medal was presented at a dinner on 12 December at the Columbia University Men's Faculty Club.

HELEN L. JEFFREY, formerly professional assistant to the program director for molecular biology at the National Science Foundation, has been named executive secretary of one of two biochemistry study sections in the Division of Research Grants, National Institutes of Health. In her new position, Dr. Jeffrey administers a program for scientifically reviewing and evaluating proposed research projects in biochemistry for which financial support is requested of the Public Health Service.

ABRAHAM M. SHANES, biophysicist in the Laboratory of Pharmacology and Toxicology, National Institute of Arthritis and Metabolic Diseases, National Institutes of Health, will serve as scientific liaison officer in biophysics with the London branch of the Office of Naval Research for the year 1959. He will be concerned with the exchange of information between American scientists and scientists abroad in the general field of cellular physical chemistry.

The following mathematicians have reported new appointments for the academic year 1958–59.

ANDRZEJ MOSTOWSKI, professor at the University of Warsaw, Poland, has been named a visiting professor at the University of California, Berkeley.

J. A. NOHEL, professor at Georgia Institute of Technology, will be on leave at the Mathematics Research Center of the University of Wisconsin.

INGRAM OLKIN, associate professor at Michigan State University is on sabbatical leave at Stanford University.

ANNE F. O'NEILL, associate professor at Wheaton College, will be on sabbatical leave in England until January 1959.

R. B. PAINE, assistant professor at Central Michigan College, has been appointed to an associate professorship at Austin State College.

RUTH M. PETERS, professor at St. Lawrence University, has been appointed to an associate professorship at the University of New Hampshire.

R. S. PHILLIPS, professor at the University of Southern California, has been appointed to a professorship at the University of California, Los Angeles.

GEORGE POLYA, professor emeritus, Stanford University, has been appointed a visiting professor at the University of California, Berkeley, for the spring term 1959.

M. A. ROSENLICHT, associate professor at Northwestern University, has been appointed to a professorship at the University of California, Berkeley.

WALTER RUDIN, professor at the University of Rochester, has been appointed a research associate at Yale University.

JOHANN SONNER of Wright Patterson Air Force Base, Ohio, has been appointed associate professor at the University of South Carolina.

F. L. SPITZER, assistant professor at the California Institute of Technology, has been appointed associate professor at the University of Minnesota.

R. R. STOLL, professor on sabbatical leave from Oberlin College, will be a senior research fellow at California Institute of Technology.

G. L. THOMPSON, assistant professor at Dartmouth College, has been appointed professor at Ohio Wesleyan University.

S. E. WARSCHAWSKI, professor on leave from the University of Minnesota, has been appointed visiting professor at the University of California, Los Angeles.

G. M. WING of the University of California, Los Alamos, N.M., has been appointed associate professor at the University of New Mexico.

ROSCOE WOODS, professor emeritus of the State University of Iowa, has been appointed visiting professor at Grinnell College.

RALPH D. LILLIE of the National Institutes of Health received the first Sustaining Membership Award of the Association of Military Surgeons on 19 November 1958 in recognition of his accomplishments in the field of histochemistry and his many contributions to experimental pathology. Lillie, chief of the Laboratory of Pathology and Histochemistry, has been with the U.S. Public Health Service for 37 years and has authored and coauthored more than 200 articles on the experimental pathology of infectious diseases, dietary disturbances, toxicology, and histochemistry. He is one of the founders of the Histochemical Society and editor of the *Journal of Histochemistry and Cytochemistry.*

R. A. GREGORY, professor of physiology at the Medical School of the University of Liverpool, England, will be the guest lecturer of the gastrointestinal section of the American Physiological Society at the time of the Federation Meetings in Atlantic City, 13–17 April. The title of his address will be "Problems of Excitation and Inhibition in the Alimentary Tract."

MELVIN N. GOUGH of Hampton, Va., for the past 16 years head of flight research at the Langley Research Center, has been assigned as director of National Aeronautics and Space Administration activities at the Atlantic Missile Range, Cape Canaveral, Fla. Gough has established an office in the administration building at Patrick Air Force Base, Fla., through the cooperation of the Air Force Missile Test Center, Air Research and Development Command. The office, to be operated under jurisdiction of NASA Headquarters, Washington, D.C., will be the focal point of NASA activity at the Atlantic Missile Range, where satellites, space probes, and other research vehicles are launched.

WILLIAM F. WINDLE, chief of the Laboratory of Neuroanatomical Sciences of the National Institute of Neurological Diseases and Blindness, has been named editor of *Experimental Neurology,* new journal of international scope. The first issue, to be published by Academic Press, Inc., New York, will appear early in 1959 and bimonthly thereafter. *Experimental Neurology* is a journal of basic research and an independent publication, nongovernmental and not affiliated with any scientific society.

Recent Deaths

G. GALE DIXON, New York, N.Y.; 73; chief sanitary engineer with Parsons, Brickerhoff, Hall & Macdonald in New York for 17 years; was responsible for the water supply and sewage works projects for Newark, Albany, Detroit, Pittsburgh, and Columbus, Ohio, and other communities in North and South America; 6 Dec.

WILLIAM D. ELLER, New York, N.Y.; 48; specialist in skin ailments and associate dermatologist at New York Center and at City and Metropolitan Hospitals; vice president of the dermatology section of the Pan-American Medical Association; coauthor of a textbook *Benign and Malignant Tumors of the Skin*; 9 Dec.

HANS R. FRIEDRICH, San Diego, Calif.; 47; assistant chief engineer for development at Convair Astronautics, where he was the leading scientist in the development of the Atlas missile; helped to develop the primary design for the Army's Redstone Missile at Huntsville, Ala.; worked with Wernher von Braun in World War II on the development of the German V-2 rocket at Peenemuende, Germany; 6 Dec.

JOHN L. GILLIN, Madison, Wis.; 87; sociologist and author whose work led to many reforms in Wisconsin's handling of criminals and the insane; retired in 1942 as chairman of the department of sociology and anthropology of the University of Wisconsin; completed *Sociology of Personal Adjustment* before his 87th birthday; 8 Dec.

ROYAL J. HASKELL, Rochester, Mass.; 68; plant pathologist who conducted plant disease research for the U.S. Department of Agriculture's Federal Extension Service; had taught at Cornell University's College of Agriculture; developed the "Haskell Dry Method" for treating seed oats for prevention of smut and other diseases; 3 Dec.

TAISIA M. STADNICHENKO, Washington, D.C.; specialist in the geochemistry of coals at the U.S. Geological Survey since 1931; began her career in 1917 as a chemist with the Russian Geological Survey, then came to U.S. after World War I; served 3 years as an instructor of chemistry at Vassar College and 6 years as a research assistant of the National Research Council; 26 Nov.

RALPH B. STEWART, Baltimore, Md.; 57; geologist and paleontologist for the U.S. Geological Survey until his retirement in 1957; had taught at Bryn Mawr College and Stanford University; 29 Nov.

ELWIN L. WILLETT, East Lansing, Mich.; 45; associate professor in Michigan State University's dairy department; director of research at the American Foundation for the Study of Genetics, 1946; assistant professor of animal husbandry at the University of Hawaii, 1943–46; performed research at the University of Puerto Rico, 1941–43; internationally known for his transplantation of the fertilized ovum from one dairy cow to another; 22 Oct.

Book Reviews

The Academic Mind. Social scientists in a time of crisis. Paul Lazarsfeld and Wagner Thielens, Jr. Field report by David Riesman. Free Press, Glencoe, Ill., 1958. xiii + 460 pp. $7.50.

The study which this book reports was apparently inspired by a characteristically provocative statement by Robert Maynard Hutchins in 1954 to the effect that the spirit of the teaching profession in America was being crushed by the then current wave of investigations of subversion on the nation's campuses.

Paul F. Lazarsfeld and his associate, Wagner Thielens, Jr., have undertaken to demonstrate the actual impact of what they call "the difficult years" on the attitudes and behavior of college professors. They have restricted their inquiry to social scientists, on the assumption that social scientists were in a more sensitive situation during that period than other academicians and were more likely to feel such pressures as might have been present, and they have gathered their information through the technique of sample surveying. They have produced an absorbing and convincing document, an important book for everyone interested in intellectual freedom.

When an epidemiologist studies the distribution of a disease he does not concern himself primarily with healthy people. Similarly, the authors of this book devote the bulk of their attention to what they take to be the harmful effects of the pressures toward orthodox political thought and behavior during the years just prior to their study (1955). Through a series of questions relative to worries about repercussions arising from the expression of political opinion and cautions observed to avoid such repercussions, they are able to describe in detail the pattern of apprehension and retreat which these pressures created. Their long chapter on "Patterns of caution" may not come as a surprise to those familiar with the academic scene, but its dramatic documentation of the manner in which many professors gave way in the face of direct or implied threat, illustrated by quotations from the interviews themselves, makes sobering reading. There can be little doubt that the voice of the ill-starred senator and his numerous apostles was heard widely through the academic grove.

As a result of the manner in which their sample was drawn, Lazarsfeld and Thielens are able to speak not only of the nation's social scientists but of its colleges as well. Thus they are able to demonstrate that it was not on the underprivileged, undistinguished colleges that the attack on nonconformist thought was concentrated but on the very colleges which their classification shows to be the outstanding universities in the country. It was on the campuses of high quality (as measured by various objective criteria) that the greatest number of accusations and actual incidents involving faculty members occurred, and this is no less true when one considers large colleges and small colleges separately. This is readily understandable when we discover that the number of professors with unorthodox views is very much greater in the colleges of high quality than it is in those of lesser distinction. Vulnerable individuals on these campuses attracted the attention of the investigators, not only to themselves but to their colleges as well. The collective effect of these individual cases was to focus the repressive campaign on the very peak of the American college system.

An analysis of particular interest in this connection describes the manner in which the administrations of these different levels of colleges met the threats to which they were exposed. It is apparent to begin with that the relationship between the administration and the faculty on the superior campuses differs substantially from that found elsewhere. The more outstanding the college, the more likely it is that the faculty has an effective voice in the determination of the college's policies regarding matters of academic freedom, and that the faculty actually meets with the administration to discuss these problems. The faculties at these colleges are more likely to feel that their administration has taken a clear-cut stand on questions of academic freedom and to feel confident that if they were actually accused of "leftist leanings," their administration would support them. They are more likely to feel that their administration has handled such incidents as have arisen in a manner which protected the rights of the faculty. While they are considerably more likely to be aware of accusations of subversion on their campuses (for the reasons just seen), they are less likely to interpret these accusations as actually threatening the academic freedom of faculty members. Despite the fact that the level of concern with questions of academic freedom is very high on the superior campuses, and that the number of professors who are themselves susceptible to attack because of their unpopular views or associations is also high, the actual incidence of cautious behavior, such as screening controversial items out of reference material assigned to students or toning down one's writing in order to avoid criticism, is lower on these campuses than on those of lesser quality. It is certainly not easy to trace all the causal relations in this complicated pattern, but the authors, quite properly in my opinion, attribute a very considerable significance to the role of the college administration in determining the impact that an attack on academic freedom will have on a college campus.

While it was inevitable that Lazarsfeld and Thielens should have concentrated their attention on the negative aspects of the "academic mind," one must not be misled into concluding that the picture is generally negative. As the authors point out, the data present a "dilemma of interpretation. Should we say that 'only' one out of ten professors have been affected in their writings, or should we be appalled by the fact that thousands of college teachers have taken such precautionary steps?" Granting the importance of the individual sinner, this book convinces me that Hutchins greatly exaggerated the impact that the various loyalty investigations were having on college faculties. Consider the following statistics: 85 percent of the social scientists interviewed denied that they had toned down anything they had written in recent years in order to avoid controversy; 85 percent denied that they were now more careful about assigning reference materials to students; 71 percent said they never went out of their way to make it clear that they had no extreme political opinions; 78 percent denied that they felt their academic freedom had been threatened in any way during the preceding few years.

One may argue that these data simply demonstrate how orthodox and noncontroversial most college professors are, and there is evidence that this is in fact a partial explanation, especially so far as the denominational colleges are concerned. The fact remains, however, that social scientists generally, and especially those in secular colleges (where most social scientists are), are far more "liberal" than the general public in their

views on political issues. No doubt many professors were unmoved by the investigations of subversion, either because they sympathized with them or because they could not imagine themselves being affected by them; other professors were threatened and drew back in the face of threat; others, including what would appear to be a substantial majority of the more distinguished members of the profession, perceived the threat clearly enough and were disturbed by it but did not yield to it. It would be regrettable indeed if this final fact were lost in the concentration which this book gives to its documentation of weakness and retreat on the campus.

To those readers of *Science* who may have come to believe that social scientists have difficulty in writing comprehensively, I am pleased to recommend this book as a model of straightforward, unpretentious exposition. The authors present a rather considerable array of statistical data, but, partly through the effective use of graphic representation, they succeed in maintaining the readability of the text. I should also urge that the reader not skip over the long postscript contributed by David Riesman, analyzing the problems of interviewing college professors. His description of the consequences of confronting "avant-garde" or "rear-guard" professors with "blue-stocking" or "market research" interviewers is both instructive and amusing.

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Embryos and Ancestors. Gavin de Beer. Clarendon Press, Oxford, England, ed. 3, 1958 (order from Oxford University Press, New York). xii + 197 pp. $4.

In 1939 Gavin de Beer published *Embryology and Evolution,* attempting to show, as he puts it, that "after rejecting the theory of recapitulation, a much better synthesis could be made of our knowledge of embryonic development and evolutionary descent, opening up new fields for observation and co-ordination of studies in embryology, genetics and evolution." In 1940 he produced an expanded and altered version of a similar argument in the first edition of *Embryos and Ancestors.* This appeared in a revised edition in 1951, and the volume under review here represents the third edition. None of the previous versions or editions has been reviewed in *Science* or was reviewed in the *Scientific Monthly* (a fact interesting and probably significant in itself). Nevertheless, since early editions of the book have been so widely read, it seems more appropriate in this review to compare the present edition with its predecessor than to discuss it as a completely new contribution to knowledge.

The third edition is a thoroughgoing revision of the second; the whole text has been reset. The main organization of the book is much the same, although some passages have been shifted in position and the chapter on the evolution of the coelenterates, which occupied two pages in the second edition, has been eliminated as a separate chapter, its content having been incorporated into the chapter on the germ layers. Clarifications and minor changes of content and of references are liberally scattered throughout the whole text, and in a number of cases actual interpretations are modified. The author, for instance, goes to great lengths in both the second and third editions to distinguish between neoteny and paedogenesis, yet one generalization specified as concerning neoteny in the second edition is referred to as paedogenesis in the third. One of the general conclusions in the second edition reads: "Phylogeny plays no causal part in determining ontogeny except in so far as past external factors have been responsible for exerting selection and preserving those internal factors which are operative in the ontogeny of the descendants." In the new edition this is shortened simply to "phylogeny plays no causal part in determining ontogeny." De Beer has also introduced some new terminology, designating as *neanic* novel evolutionary characters which have made their appearance early in ontogeny and as *ephebic* those which have appeared at later stages in the life history of the individual. The principal change in the new edition is one of size. While the actual text (minus bibliography and index) of the second edition occupies 142 pages, that of the third fills 174 pages. The bibliography is increased from more than 270 references to over 350. One new illustration has been added, and one new table, both from the work of A. H. Schultz.

The material added in the latest edition includes amplification of what was said, in the earlier editions, of the positions of the classical authors of the 19th century, and also the exposition and discussion of new data, some of which became available only after the appearance of the preceding edition. In some cases, in the text and in one table, examples are multiplied—in particular, more evidence is drawn from the plant kingdom than in the previous edition. Where new evidence is brought in, it is drawn principally from the same fields as in earlier editions—from the study of morphogenesis, taxonomy, natural history, evolution. Since so much of the argument hinges on the time of action of genes, it is a great pity that no reference is made to von Ubisch's success with androgenetic merogony or to Briggs' success with nuclear transplantation. De Beer has failed, furthermore, to take up any of the modern studies on developmental genetics which are so apposite to his theme and thus has missed his opportunity to effect the synthesis between embryology, genetics, and evolution which he has stated to be his primary aim.

A number of embryologists now question whether attacks on the recapitulation theory are any longer necessary. Certainly a number of recent textbooks, while they may still describe the doctrine, refute it at the same time, and there seem to be increasingly fewer which labor it as tenable. Whether or not, however, belief in recapitulation is a present danger, de Beer's continuing attempts to bring together data from embryology and evolution are commendable, and the resulting books provide stimulating collateral reading for students.

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Pollen and Spore Morphology/Plant Taxonomy. Gymnospermae, Pteridophyta, Bryophyta. (*An Introduction to Palynology,* vol. 2). G. Erdtman, Ed. Almquist and Wiksell, Stockholm; Ronald, New York, 1957. 151 pp. Illus. $8.

This volume is divided into three parts. The first and major portion is devoted to illustrations of pollen grains of 57 genera of gymnosperms and of spores of 113 genera of pteridophytes and 69 genera of bryophytes. The second section, by B. Afzelius (Gulveg), discusses new methods of studying the wall structure. The third part, by J. Eadwan Pragloiski, is on the preparation of ultrathin sections.

The pollen and spore illustrations depict distinguishing characteristics of one or more species, either as entire palynograms or as sketches illustrating structural details of the exine or sclerine of similar species or genera. The text for these illustrations will be published as volume III of the series. This is the first comprehensive coverage of these categories on a world-wide basis. Figure 2 is especially helpful to beginning palynologists in that it shows lateral, distal, and proximal perspective sketches of the same grain. Fern spores have been illustrated previously by many authors, usually for local geographical areas, but this treatment brings into one place illustrations of genera that are found in widely separated floras. Very few authors have

given attention to spores of mosses; thus, these illustrations are especially helpful.

Afzelius' discussion covers the use of new techniques such as phase contrast, ultraviolet light, polarization, interference, and electron microscopy. The use of these aids is just beginning and in time will contribute to the interpretation of the minute details of pollen-wall structure. A few of the species already studied by electron microscopy of ultrathin sections show that exine is homogeneous and thus not properly divisible into the sexine and nexine layers.

Pragloiski gives detailed instructions about methods of embedding pollen or spores in methacrylate and of making the modifications of the block and microtome necessary to secure sections of from 0.25 to 0.50 microns in thickness.

It is regrettable that text and illustrations were not published together. The change of the series title from the *Pollen Morphology and Plant Taxonomy* of volume I to that of the present book presents a cataloging problem in that each volume has a separate call number and thus they are not shelved together.

This book will be a major reference volume for palynologists.

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Abortion in the United States. A conference sponsored by the Planned Parenthood Federation of America, Inc., at Arden House and the New York Academy of Medicine. Mary Steichen Calderone, Ed. Hoeber-Harper, New York, 1958. vii + 224 pp. $5.50.

Pregnancy, Birth and Abortion. Paul H. Gebhard, Wardell B. Pomeroy, Clyde E. Martin, and Cornelia V. Christenson. Hoeber-Harper, New York, 1958. xiii + 282 pp. Illus. $6.

One of the most important medicolegal and sociological problems in human eugenics today is induced or criminal abortion. Although the medical profession has been long aware of the magnitude of this problem, it has not been apparent to the general public. Little knowledge has been available concerning the frequency of the procedure in single and married women; its impact on the individual, the family and society; or the basic reasons for seeking an abortion. Such basic information is of paramount importance in the development of rational measures to combat this undesirable practice.

Two very informative books on this subject have just been published, and together they provide a wealth of data on the abortion problem. The first book, *Abortion in the United States,* is the report of a conference on abortion sponsored by the Planned Parenthood Federation of America. The late Alfred Kinsey, a member of a panel at this conference, was motivated to initiate the second study, *Pregnancy, Birth and Abortion.*

Abortion in the United States is a report of a conference on the problem of induced abortion—criminal and therapeutic. The 38 participants included physicians, sociologists, psychologists, religious leaders, and other interested individuals. At the present time there are no laws which control the practice of illegal abortions. The woman who resorts to pregnancy termination is often emotionally disturbed. Family, social, and economic factors may enter into the causation of the pregnancy and its undesirable end. Induced abortions may be traumatic experiences for the individuals involved and do not solve underlying basic problems. Induced abortions grossly estimated at more than one million per year are not in the medical, social, and public interest, and steps should be taken to reduce the incidence appreciably.

The members of the panel suggested the following five steps to reduce the frequency of induced abortion:

1) Medical, psychological, and social studies of women seeking abortions should be sponsored by governmental and private agencies.

2) Consultation centers for women seeking abortions, such as are found in Scandinavian countries, should be established; the main function of these would be to help women realize that abortion is not the only solution to the problem.

3) Facilities for obtaining contraceptive advice under medical supervision should be improved, although it has not been definitely established that availability of contraceptive advice will decrease the number of induced abortions.

4) There should be early, continued, realistic sex education.

5) There should be a joint effort on the part of all bodies concerned to study present-day abortion laws of the various states and frame a practical, workable statute which could be adopted on a nationwide basis.

Pregnancy, Birth and Abortion is the third volume published by the Institute of Sex Research. The authors have analyzed pregnancy out of wedlock and induced abortion from all aspects, utilizing coded interviews with 7074 women, of whom 1209 were prison inmates. The book is concerned with conceptions among unmarried females and the prevalence of induced illegal abortions among married and unmarried women in this country. It is noteworthy that 75 percent of married women experience a live birth, 25 percent experience one or more spontaneous abortions, and 25 percent admit to one or more induced abortions. The total number of abortions in married women is greater than in the unmarried, although fewer married women have induced abortions. The incidence of abortion in married women decreases as the level of their education is raised. Ten percent of unmarried women experience pregnancy by age 30, and 89 percent of these pregnancies are terminated by abortion. The incidence of abortion in previously married women is 79 percent. The average woman regards the divorcee as a sexual competitor.

The age of the woman at the time of her marriage, the decade in which she was born, and the intensity of her religious faith were studied. Methods of inducing abortion as well as the prevailing cost were investigated. Surprisingly, the ill effects of abortion were found to be few, and the procedure did not interfere with sexual enjoyment or the possibility of marriage.

The volume contains an abundance of factual material of great interest to the physician, the sociologist, the psychologist, and others interested in an important problem.

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Quantitative Inorganic Analysis. G. Charlot and Denise Bézier. Translated by R. C. Murray. Methuen, London; Wiley, New York, ed. 3, 1957. x + 691 pp. Illus. $15.

This text is a faithful translation of the original French version published in 1955, even to the reproduction of the figures and tables. By a more condensed printing, the number of pages has been reduced by about 130. The chapter numbers in part II have been deleted.

Part I, comprising 33 chapters which take up half the book, deals with the various types of analytical chemical operations, such as acidimetry, oxidimetry, titrimetry, precipitation and separation by precipitation, chromatography and ion-exchange, separation by distillation, determination by means of different solvents, extraction, gravimetric methods, instrumental analysis, spectrophotometry, colorimetry, spectrography, electrometric analysis, polarography, potentiometric analysis, coulometry, methods utilizing radioactivity, determination of trace elements, methods of effecting solution of samples, and gas analysis, as well as discussions of precision of measurement and statistical methods. In this new edition the principal instrumental methods—absorption spectrophotometric and electrochemical—have been treated fully.

Part II deals with the determination of the various elements, arranged alphabetically. The style of presentation follows a general pattern, with variations depending on the element discussed: separation, gravimetric, volumetric, colorimetric, potentiometric, and electrolytic methods, as well as special cases. Condensed abstracts of methods of determination are given, with selected references that direct the reader to the most reliable original publications for details. This method of presentation permits the inclusion of a great amount of information and avoids the danger of giving erroneously written procedures.

In addition, the book contains a brief table of densities and concentrations of the common acid and alkali solutions, a table of conversion factors, a selected bibliography, a subject index, and an author index.

In making the French text available in English, the translator has rendered the analytical chemist a great service.

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Yearbook of International Organizations, 1958–59. Published in official collaboration with the United Nations. Union of International Associations. Brussels, Belgium, 1958. 1269 pp. $14.

This is a comprehensive guide to the various aspects of international cooperation. The subject matter is divided into six main sections—the United Nations; the European Community; other intergovernmental organizations; international non-governmental organizations; national organizations in consultative status with the United Nations, and national institutes of international affairs; there are English and French subject indexes, a list of initials, and a geographical index.

The entry for each organization gives its name, addresses, regional secretariats, representative at the United Nations in New York and Geneva, history, aims, members, structure, staff, and working languages; the names and nationalities of its officers; and its budget, activities (including congresses, past and future), and publications.

The *Yearbook* is published by the Union of International Associations. In the foreword, Wallace W. Atwood, Jr., director of the Office of International Relations, National Academy of Sciences of the United States, says, "Because of the growing importance of international organizations in the planning and execution of international programs, more and more people in governmental and private positions of responsibility, have occasion to seek accurate and up to date information about these organizations. . . . Every embassy, foundation, research council, library, and agency of government concerned with international affairs should have one or more copies of the *Yearbook* for ready reference."

New Books

The Chemical Analysis of Foods and Food Products. Morris B. Jacobs. Van Nostrand, Princeton, N.J., ed. 3, 1958. 994 pp. $13.75.

Classification and Indexing in Science. B. C. Vickery. Academic Press, New York; Butterworths, London, 1958. 202 pp. $5.50.

Men of Science in America. The story of American science told through the lives and achievements of 20 outstanding men from earliest colonial times to the present day. Bernard Jaffe. Simon and Schuster, New York, rev. ed., 1958. 733 pp. $6.95.

The Miami Years, 1809–1959. Walter Havighurst. Putnam's, New York, 1958. 254 pp. $4.50.

Nuclear Engineering Handbook. Harold Etherington, Ed. McGraw-Hill, New York, 1958. 1872 pp. $25.

The Orchestra of the Language. Ernest M. Robson. Yoseloff, New York, 1958. 206 pp. $5.50.

Organic Syntheses with Isotopes. pt. II, *Organic Compounds Labelled with Isotopes of the Halogens, Hydrogen, Nitrogen, Oxygen, Phosphorus, and Sulfur.* Arthur Murray, III, and D. Lloyd Williams. Interscience, New York, 1958. 959 pp. $25.

Polar Atmosphere Symposium. Held at Oslo, 2–8 July 1956. pt. 1, *Meteorology Section*; R. C. Sutcliffe, Ed.; 352 pp.; $12. pt. II, *Ionospheric Section*; K. Weekes, Ed.; 225 pp.; $10.50. Pergamon, New York and London, 1957.

Reproductive Physiology. Comparative reproductive physiology of domestic animals, laboratory animals and man. A. V. Nalbandov. Freeman, San Francisco, Calif., 1958. 271 pp. $6.75.

Practical Clinical Biochemistry. Harold Varley. Interscience, New York; Heinemann, London, ed. 2, 1958. 643 pp. $6.50.

Reversicon, A Medical Word Finder. J. E. Schmidt. Thomas, Springfield, Ill., 1958. 455 pp. $7.50.

Russian-English Medical Dictionary. Stanley Jablonski. Ben S. Levine, Ed. Academic Press, New York, 1958. 434 pp. $11.

Some Problems of Chemical Kinetics and Reactivity. vol. I, N. N. Semenov. Translated by J. E. S. Bradley. Pergamon, New York and London, 1958. 315 pp. $12.50.

The Air. Edgar B. Schieldrop. Philosophical Library, New York, 1958. 256 pp. $12.

Handbuch der Physik. vol. 12, *Thermodynamics of Gases.* S. Flügge, Ed. Springer, Berlin, 1958. 686 pp. DM. 154.

International Conference on Scientific Information, Washington, D.C., November 16–21, 1958. Preprints of papers. Sponsors: National Science Foundation, National Academy of Sciences–National Research Council, American Documentation Institute. National Academy of Sciences–National Research Council, Washington, D.C., 1958. 7 sections.

Introducing Mathematics. Floyd F. Helton. Wiley, New York; Chapman & Hall, London, ed. 2, 1958. 411 pp.

An Introduction to Fluid Dynamics. F. J. Bayley. Interscience, New York, 1958. 223 pp. $4.50.

Low Temperature Physics and Chemistry. Proceedings of the Fifth International Conference on Low Temperature Physics and Chemistry. Held at the University of Wisconsin, Madison, 26–31 August 1957. Joseph R. Dillinger, Ed. University of Wisconsin Press, Madison, 1958. 701 pp. $6.

Man's World of Sound. John R. Pierce and Edward E. David, Jr. Doubleday, Garden City, N.Y., 1958. 287 pp. $5.

The Metabolism of Sulphur Compounds. Leslie Young and George A. Maw. Methuen, London; Wiley, New York, 1958. 180 pp. $3.

Moments of Discovery. vol. I, *The Origins of Science*; vol. II, *The Development of Modern Science.* George Schwartz and Philip W. Bishop, Eds. Basic Books, New York, 1958. 1005 pp. $15.

Organizations. James G. March and Herbert A. Simon. With the collaboration of Harold Guetzkow. Wiley, New York; Chapman & Hall, London, 1958. 273 pp. $6.

Statistical Physics. vol. 5 of *Course of Theoretical Physics.* L. D. Landau and E. M. Lifshitz. Translated from the Russian by E. Peierls and R. F. Peierls. Pergamon, London; Addison-Wesley, Reading, Mass., 1958. 494 pp. $12.50.

Handbuch der Physik. vol. 38, pt. 1, *External Properties of Atomic Nuclei.* S. Flügge, Ed. Springer, Berlin, 1958. 471 pp. DM. 118.

Reprints

The Fundamental Principles of Quantum Mechanics with Elementary Applications. Edwin Kemble. Dover, New York, 1958 (unabridged republication of ed. 1, 1937). 629 pp. $2.95.

Introduction to Bessel Functions. Frank Bowman. Dover, New York, 1958 (unaltered republication of ed. 1). 145 pp. $1.35.

An Introduction to Fourier Methods and the Laplace Transformation. Philip Franklin. Dover, New York, 1958 (unaltered republication of *Fourier Methods*, 1949). 299 pp. $1.75.

Statics and the Dynamics of a Particle. William Duncan MacMillan. Dover, New York, 1958 (unaltered republication of ed. 1, 1927). 448 pp. $2.

Theoretical Mechanics. An introduction to mathematical physics. Joseph Sweetman Ames and Francis D. Murnaghan. Dover, New York, 1958 (unaltered republication of ed. 1, 1929). 473 pp. $2.

Vector Analysis with an Introduction to Tensor Analysis. A. P. Wills. Dover, New York, 1958 (unabridged republication of ed. 1, 1931). 317 pp. $1.75.

Reports

On Evaporation from Wind-Swept Surfaces

Abstract. Evaporation is analyzed in terms of resistances and driving forces for the coupled flows of vapor and heat. The conditions and assumptions under which all resistances can be determined independently are discussed, and preliminary experiments are reported. The effect of a monomolecular layer upon the transport of vapor is thus measured on a wind-swept surface, and its effect upon heat transport in the water is indicated.

The use of monolayers in evaporation control of reservoirs is assuming considerable importance (*1*), yet it seems to be based primarily on fundamental studies of film resistance on quiescent surfaces (*2*). The present report has been written to point out that the rate of evaporation can depend on a number of factors in addition to the film resistance, and that these can either be measured directly or estimated on the basis of reasonable assumptions with respect to a wind-swept surface.

Figure 1 illustrates schematically the specific resistances and specific driving forces involved during evaporation. The driving force for the transport of water is the difference between the pressure of the vapor in equilibrium with the water surface (P_s) and in the air above it (P_h). This vapor encounters the resistance of the air (R_a) and of the surface film, if any (R_f). Its flow per unit surface (W_t) is therefore given by

$$W_t = (P_s - P_h)/(R_a + R_f) \qquad (1)$$

The process of evaporation is highly endothermic (about 585 cal/g); hence the flow of vapor must be coupled to an equivalent flow of heat, and this can be conveniently expressed in the same units (W_t). This heat can flow only from the air (W_a) or from the bulk of the water (W_w). Hence:

$$W_t = W_a + W_w \qquad (2)$$

The flow of heat from the air encounters an air resistance r_a but is certainly not impeded by a monomolecular layer. The difference between the air temperature (T_a) and the temperature of the surface (T_s) provides the driving force:

$$W_a = (T_a - T_s)/r_a \qquad (3)$$

Similarly, the flow of heat from the bulk of the liquid is caused by the difference between the temperature of the bulk of the water (T_w) and that of the surface (T_s) against a resistance r_w:

$$W_w = (T_w - T_s)/r_w \qquad (4)$$

Experimentally it is possible to determine directly T_a, T_w, W_t, and W_w and the relative humidity of the air. Tables then give P_h and P_w (the equilibrium vapor pressure of the bulk water), and W_a is obtained from Eq. 2. The surface quantities T_s and P_s and the resistances cannot in general be measured directly.

The situation is simplified if no heat is supplied to the bulk of the water—by keeping it in a well-insulated vessel—so that $W_w = 0$ when a steady state is reached. Under these "acaloric" conditions there can be no difference between bulk and surface temperature as shown by Eq. 4, and therefore surface temperature and vapor pressure become directly measurable: $T_s = T_w$, $P_s = P_w$. This gives directly, then, the thermal resistance of air and the total resistance to vapor, from Eqs. 2 and 1:

$$r_a = (T_a - T_w)/W_t \qquad (5)$$

$$R_a + R_f = (P_w - P_h)/W_t \qquad (6)$$

When, in addition, no film is present —that is, when the surface is clean— $R_f = 0$, and Eq. 6 gives directly the vapor resistance of the air (R_a). These are psychrometric conditions determining the "wet bulb" temperature. The wet bulb temperature is constant for a given relative humidity and temperature over a wide range of wind velocities although the rate of evaporation changes. This shows that R_a/r_a is substantially constant, so that $R_a = Kr_a$. The value of the constant K can be determined experimentally for any given conditions, or it can be calculated from psychrometric tables which give $K \cong 0.50$ mm-Hg per degree centigrade. Introducing this into Eq. 5 and 6 gives directly the film resistance:

$$R_f = [P_w - P_h - K(T_a - T_w)]/W_t \qquad (7)$$

in terms of experimental quantities.

It may be noted that the effect of a film resistance is to raise the acaloric temperature above the psychrometric one, and this effect increases with increasing wind velocity—that is, decreasing $r_a/(R_a + R_f)$.

If conditions are not acaloric but heat is supplied to the water at a constant rate, the air and film resistance should not be affected. Knowledge of these resistances permits two independent estimates of the surface temperature, one directly by Eq. 3, the other through P_s from Eq. 1. Agreement of the two values is an indication of the correctness of the assumption of the constancy of the resistances. Once surface temperature has been estimated, Eq. 4 gives directly the resistance encountered by heat within the water.

Preliminary measurements along these lines have been made with a simple apparatus based on a 15-cm crystallizing dish fitted with a side arm and set in foamed plastic insulation above a bare-wire electric heater also surrounded by the insulation. An adjustable air stream was provided by a blower, and the rate of evaporation was measured by the amount of water required to restore the level, as indicated by a sharp point located just below the surface. The whole was operated in an air-conditioned room

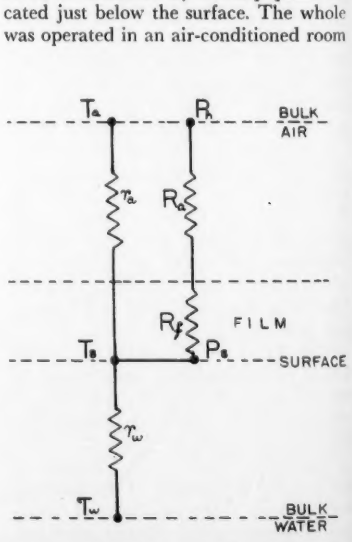

Fig. 1. The resistances and driving forces in the coupled flows of heat (left) and water vapor (right) during evaporation.

Instructions for preparing reports. Begin the report with an abstract of from 45 to 55 words. The abstract should *not* repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the report proper. (Since this requirement has only recently gone into effect, not all reports that are now being published as yet observe it.)

Type manuscripts double-spaced and submit one ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

Limit illustrative material to *one* 2-column figure (that is, a figure whose width equals two columns of text) or to *one* 2-column table or to *two* 1-column illustrations, which may consist of two figures or two tables or one of each.

For further details see "Suggestions to Contributors" [*Science* 125, 16 (1957)].

to reduce fluctuations in temperature and relative humidity. A few bits of commercial cetyl alcohol sprinkled by hand on the surface of the water provided the resisting film. Imperfectness of the insulation seems to have been the limiting factor on the accuracy and range of the measurements. Reproducibility of the film was also somewhat haphazard.

At a high wind velocity of about 18 mi/hr the acaloric steady-state temperature was raised by 4.4°C as a result of the film, while at a lower wind velocity of about 6 mi/hr, the effect was 3.8°C. The corresponding resistances were $r_a = 4.2$ and 7.5×10^5 °C sec cm²/g; $R_f = 20$ and 22×10^5 mm-Hg sec cm²/g, or, in centimeter-gram-second units, $R_f = 2.1$ sec/cm within experimental error. When the water was heated, the experimental uncertainty in W_a was too large to make it useful in determining the surface temperature through Eq. 3. Equations 1 and 4 were therefore used to estimate the thermal resistance of water (r_w). The values found did not seem to depend appreciably on wind velocity but increased markedly in the presence of film, especially when heat input was small and bulk temperature was close to surface temperature. They ranged from $0.4 \pm 0.15 \times 10^5$ °C sec cm²/g for a clean surface to 1.4×10^5 in the presence of a film when $T_w - T_s \cong 3$°C and 2.6×10^5 when $T_w - T_s \cong 0.8$°C. These effects suggest that convection currents are the main factor determining r_w.

Rather surprisingly, the film had no perceptible effect upon the thermal resistance of air (r_a). Thus, the quieting effect of a monolayer (*3*)—the calming of troubled waters—which is so prominent in field tests of evaporation control (*4*) seems not to affect the rate of evaporation under the conditions of these small-scale experiments (*5*).

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15 September 1958

Effect of Interruption of the Visual Pathway on the Response to Geniculate Stimulation

Abstract. Optic nerve section or destruction of the lateral geniculate nucleus increased the amplitude and elevated the recovery cycle of the cortical response to lateral geniculate radiation stimulation in cats. The lesions may have acted by eliminating tonic inhibitory or occlusive volleys originating in the retina, or both.

Since publication of the initial descriptions of the cortical response to electrical stimulation of the geniculo-striate pathway (*1*) there have been a number of studies of the anatomical substrate (*2*) and recovery cycle (*3, 4*) of this response. Recent studies of this recovery cycle (carried out in unanesthetized cats with chronically implanted electrodes) showed that a stimulus to the lateral geniculate radiations was followed by subnormality lasting 1 second or more (*5*). In recent studies of the factors underlying this prolonged subnormality, it was found that optic nerve section or destruction of the lateral geniculate nucleus markedly altered the recovery cycle of the cortical response to lateral geniculate radiation stimulation. The present report describes these observations.

Adult cats were anesthetized with pentobarbital, ether, or urethane and placed in a stereotaxic instrument. Stimulating electrodes in the lateral geniculate radiations delivered a pair of shocks every 5 seconds. The first (conditioning) stimulus of the pair preceded the second (test) stimulus by 3.2 to 1600 msec. The evoked responses were recorded from the surface of the lateral gyrus with a pore electrode. Lesions of the lateral geniculate were produced electrolytically. The optic nerve was interrupted by freezing or by clamping.

Interruption of both optic nerves or destruction of the ipsilateral lateral geniculate caused a decrease in variability and an increase in amplitude of the postsynaptic components of the cortical response to geniculate radiation shock. Such lesions also caused a marked decrease in the degree of subnormality of the surface positive components, though not of the surface negative component, of the test response (Fig. 1). Figure 2 presents a graph of a recovery cycle before and after optic nerve section. These effects could be demonstrated in cats anesthetized with each of the three anesthetics employed.

Several experimental variables modified the degree to which recovery was enhanced following interruption of the visual pathway. One of these was stimulus intensity, recovery being enhanced more for the responses to supramaximal than for those to near-threshold stimuli. A second variable was the relative position of the stimulating and recording electrodes. The responses in cortical positions outside the maximal cortical focus of the stimulating electrodes showed marked increase in amplitude, but the enhancement of the recovery cycle was relatively slight. On the other hand, at the maximal focus, responses showed less increase in amplitude but more enhancement of the recovery cycle.

Several hypotheses may be offered as to the mechanism by which interruption of the visual pathway exerts these effects. The lesions might act by eliminating the

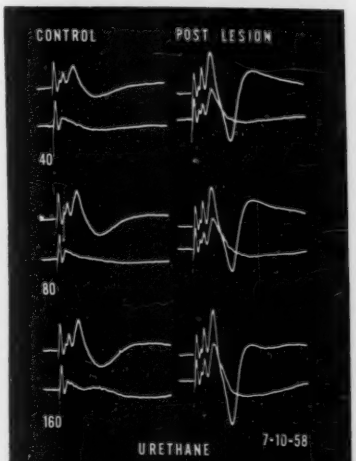

Fig. 1. Cortical responses to paired geniculate radiation shocks before (left) and after (right) optic nerve section under urethane anesthesia. Separations between the shocks of each pair are indicated at the left of each row. Following the lesion there is an increase in amplitude of all components of the response. Positive is up.

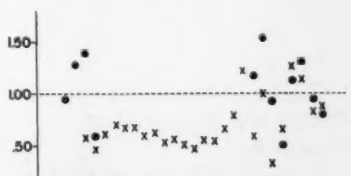

Fig. 2. The recovery cycle of the major positive component (C_4) of the cortical response to geniculate radiation stimulation before (dots) and after (crosses) optic nerve section. On the abscissa is plotted separation (in milliseconds) between paired shocks. On the ordinate is plotted the ratio of the amplitude of C_4 (the major positive component of the test response) to C_4 of the control. Following the lesion, depression of the test response between 10 and 250 msec was much less marked than it had been before the lesion.

background of spontaneous afferent impulses reaching the cortex from the retina. This background activity may be inhibitory or excitatory, or both, and the changes in the cortical response might thus result from elimination of tonic inhibitory or occlusive influences, or both. It is also possible that the lesions alter cortical excitability secondarily, as a result of an alteration of excitability of the central structures (*6*) to which the slower-conducting optic nerve fibers project. These structures may, in part, mediate the prolonged effects of the conditioning volley on the test response.

Regardless of what mechanism is ultimately shown to operate, the present experiments indicate the large extent to which the recovery processes of the primary visual cortex depend upon impulses reaching the central nervous system from the peripheral visual apparatus.

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27 August 1958

Utilization of Porphobilinogen Carbon-14 in Biosynthesis of Vitamin B_{12}

The structural formula of vitamin B_{12} proposed by Hodgkin (*1*) and by Bonnet (*2*) and their colleagues focused attention on the probable presence of a cobalt-binding porphyrin-like moiety in the molecule. Despite its unique character, the tetrapyrryl ring structure indicated the likelihood that common pyrrol precursors for this vitamin and for the various naturally occurring porphyrins were present. In the George R. Minot lecture (*3*) in June 1956, mention was made of our observation that porphobilinogen, the monopyrrolic precursor of uro-, copro-, and protoporphyrin, is readily utilized in the formation of vitamin B_{12} by a bacterial culture. At about the same time Shemin *et al.* (*4*) reported the incorporation of δ-amino-levulinic acid into vitamin B_{12} under similar conditions.

Table 1. Recovery of vitamin B_{12}-C^{14} from a bacterial culture incubated with porphobilinogen-C^{14}. Background count, 22.0 ± 0.6 count/min for experiment No. 1 and 26.4 ± 0.7 and 27.6 ± 0.7 count/min, respectively, for experiments No. 2 and 3 (60 min each). A correction factor was applied to correct for self-absorption of NaOH used as solvent and for differences in background counts.

	Expt. 1	Expt. 2	Expt. 3
Porphobilinogen added (mg)	12.6	22.5	22.2
Vitamin B_{12} produced (mg)	0.15	1.29	1.47
Carrier added (mg)	10.1	10.2	8.83
Carrier + B_{12} recovered (mg)	6.91	5.41	2.98
Amt. in planchet (mg)	0.33	0.216	0.119
Duration of count (min)	120.	300.	300.
Count/min above background	23.1 ± 0.6	20.4 ± 0.4	7.6 ± 0.4
Count/min corrected	38.4	28.9	10.2
Count/min mg of B_{12} produced	8000.	1200.	600.
Count/min μmole of B_{12} produced	10800.	1630.	810.
Count/min μmole of B_{12} per C^{14} carbon atom	1540.	233.	116.

The present report describes the conditions and results of the porphobilinogen C^{14}-vitamin B_{12} studies (*5*).

Carbon-14 labeled porphobilinogen was prepared as follows: Two rabbits were treated with allyl-isopropyl-acetylcarbamide (Sedormid) for 10 days. Each rabbit then received a total of 160 μc of glycine-2-C^{14} subcutaneously in five divided doses over a 36-hour period. The urine was collected during this period and for the next 6 days. The pooled 975 ml of urine contained 310 mg of porphobilinogen as determined by quantitative analysis of the Ehrlich aldehyde reaction. The pooled urine was subjected to the method of Cookson and Rimington (*6*) for the isolation of porphobilinogen; 102 mg of crystalline porphobilinogen were obtained.

Some crystalline material was dissolved in H_2O and evaporated on a planchet for radioactivity measurement. A specific activity of 6300 count/min per milligram was observed. Solubility properties and the intensity of the Ehrlich aldehyde compound were similar to those found with repeatedly recrystallized porphobilinogen isolated from urine of patients with acute intermittent porphyria.

Ninety milligrams of the crystalline compound were placed in an evacuated and sealed ampule and sent to the Merck Laboratory for further study. Here the crystalline porphobilinogen was dissolved in 0.1*N* sodium hydroxide and sterilized by filtration before being added to the sterile nutrient medium (*4*). It was incubated with the bacterial culture in three separate experiments. In the first study, 12.6 mg (56 μmole) of porphobilinogen was added at time 0; in each of the other studies, a total of 22 mg (97 μmole) was added to three divided portions, at time 0 and again after 1 and 2 days' incubation, respectively. The broths were all harvested after 4 days. The vitamin B_{12} content of the broth was assayed microbiologically. Carrier B_{12} was then added to facilitate isolation. Radioactivity measurements were performed with a windowless gas-flow counter, with suitable correction made for self-absorption of the samples evaporated on a steel planchet.

The observed radioactivity of the porphobilinogen at the Merck Laboratories was 6900 count/min per milligram or 1560 count/min per micromole. This corresponds to an activity of 780 count/min per micromole for each of the two labeled carbon atoms in the molecule (*7*).

As is shown in Table 1, the calculated activities of the vitamin B_{12} produced ranged from 810 to 10,800 count/min per micromole of vitamin B_{12} produced. If one assumes labeling of seven carbon atoms in the vitamin corresponding to the two labeled carbon atoms in porphobilinogen (*7*) (one alpha carbon atom in each of the four pyrrole rings and three bridge carbon atoms), it would appear that approximately one-third and one-half of the porphyrin-like moieties were derived from the added porphobilinogen-C^{14} in experiments 2 and 3, respectively. In the first experiment, however, the radioactivity recovered is greater than can be accounted for on the basis of the observed production of only 0.15 mg of vitamin B_{12}. It is evident that the many possible additive errors inherent in such a calculation do not permit precise estimation of the dilution factor involved in the incorporation of the added porphobilinogen C^{14} into vitamin B_{12}.

The present result, coupled with that of Shemin and his coworkers with δ-aminolevulinic acid, clearly reveals that the biosynthesis of the porphyrin-like moiety of vitamin B_{12} is along the same primary pathway as that of other naturally occurring porphyrins. The

point of divergence in the pathway, beyond porphobilinogen, remains to be determined. It appears unlikely that uro- or coproporphyrin is involved, as this would require partial degradation—that is, removal of the δ-methene bridge to provide the curious C=C linkage in the porphyrin-like moiety of B_{12}. Nevertheless it would be of interest to determine whether uroporphyrinogen III might be utilized in B_{12} synthesis, as it is in that of the hemoglobin protoporphyrin (*8*).

While vitamin B_{12} is essential to normal erythropoiesis and resembles the heme compounds to the extent of having a porphyrin-like group in its molecule, there is no evidence that vitamin B_{12} deficiency is associated with diminished porphyrin or bile pigment formation. As discussed elsewhere (*9*), the available evidence indicates that in pernicious anemia there is plentiful formation of pyrrol pigment.

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30 October 1958

Ecological Significance of Red Light Sensitivity in Germination of Tobacco Seed

Abstract. The light transmission of different soil materials was measured in a Beckman spectrophotometer. The relative energy transmission was greatest at the red end of the spectrum. A seed sensitive to red light will have the capacity to germinate at nearly the maximum depth of penetration by visible light, where the risk of early desiccation is diminished.

It has been established that red light is much more effective than light of shorter wavelength in promoting germination of some light-requiring seeds, the blue end of the spectrum being least effective (*1*). Investigation of the light requirement of seeds of the tobacco, *Nicotiana trigonophylla* Dun., gave similar results in the present study.

If a deductive approach may be taken, the question is: What is the ecological significance of red light sensitivity for seed germination? We know that the amount of diffraction or scattering of light by small particles or openings varies inversely as the fourth power of the wavelength; therefore it seems likely that fine soil particles, and especially the finer interstices between them, might scatter blue light more than red. This means that red light would penetrate the soil to a greater depth than blue light, and that below the soil layer where the first scattering takes place (the surface), the penetrating light will be impoverished in the blue end of the spectrum compared with the incident light.

An investigation was made of the transmission spectrum of a medium-coarse quartz sand and of a silty clay, with the Beckman DU spectrophotometer. It was found that a 5-mm thickness of wet silty clay gave zero light transmission at all wavelengths measured, even when a blank was used which reduced the slit area, and hence the level of the blank signal relative to the sample signal. Therefore it was necessary to use a dilute suspension, and the blank for this sample was 5 mm of distilled water. The wet sand was more translucent than the silty clay, but it was necessary to use an arbitrary blank which reduced the slit area, since with the usual slit openings, the blank gave such a high signal relative to the sample signal that the latter registered zero transmission at all wavelengths. This blank was a series of holes in black tape arranged in linear fashion, so that all fell within the slit image.

The transmission spectra of these soils, in the wavelength range from 400 to 800 mμ, are presented in Figure 1; a comparison of the ratios of percentage transmission of longer to shorter wavelengths is provided in Table 1.

It is evident that the relative energy transmission in the shorter wavelengths is smaller than in the longer wavelengths when light is passed through these materials. The greater loss in the blue end of the spectrum may be due to specific absorption and refraction effects in addition to diffraction.

Table 1. Ratios of percentage transmission of longer to shorter wavelengths.

Soil	Percentage transmission ratios	
	655 mμ/450 mμ	735 mμ/655 mμ
Sand, 10 mm	6.0	1.6
Sand, 5 mm	2.5	1.2
Clay suspension	1.9	1.1

Radiation of wavelength 735 mμ is reported to inhibit the germination of many light-sensitive seeds (*1*); and since 735-mμ light has a higher percentage transmission in soil than 655-mμ light (see Table 1), it may be inferred that there is some level below the soil surface where the inhibiting effects of far-red radiation will prevail. But since this level would be just above the zone of perpetual darkness, the only effect is to extend that zone upward, as far as light-sensitive seeds are concerned.

With regard to the ecology of the genus *Nicotiana*, an outstanding characteristic is the adaptation to the rapid, early invasion of pioneer or disturbed sites, free of dense vegetation (*2*). This mobility is due primarily to the enormous production of very minute seeds with rough, reticulate coats, which provide great powers of dispersal, whether due to the agency of wind or animals. On the other hand, the small seed carries with it the disadvantage of a small food reserve, which limits the depth of successful germination to the magnitude of the relatively small dark-elongation of the hypocotyl. Hence much seed would be lost by dark germination following slight burial were it not for the fact that the seeds of many of the species are light

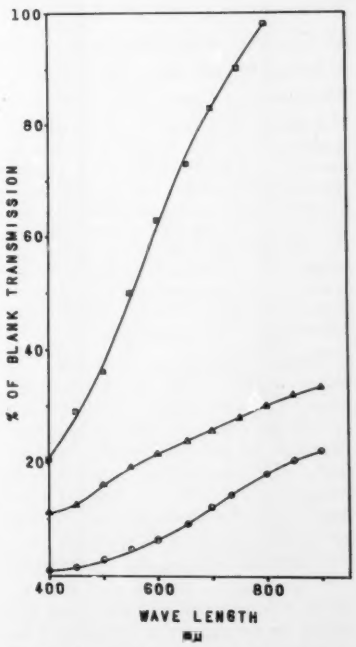

Fig. 1. Transmission spectra of quartz sand and a clay suspension. Top curve, quartz sand (5 mm); middle curve, quartz sand (10 mm); bottom curve, clay suspension (5 mm).

requiring, which insures germination near the surface. However, the soil-air interface is a harsh environment. As the center of radiation exchange, it undergoes the most rapid and extreme temperature changes, and with regard to the moisture factor, it is alternately bombarded by splattering raindrops and subjected to severe droughts. Therefore, any depth below the surface, however slight, will be an improvement from the standpoint of an environment for germination of seeds. If then, a seed is light-requiring, it is of some survival value for it to be red sensitive, since this property will facilitate germination at nearly the maximum depth of penetration by visible light. Of course, this will not prevent the seed from germinating on or near the surface, where the risk of early desiccation is greater; it merely confers on the seed the capacity to germinate where this risk is diminished.

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16 September 1958

Critical Period for Effects of Infantile Experience on Maturation of Stress Response

Abstract. Manipulated infant rats respond to cold with depletion of adrenal ascorbic acid (AAA) significantly earlier than nonmanipulated infants. The study discussed in this report examined the critical period for infantile manipulation on the depletion of AAA. It was found that infant rats manipulated immediately following birth exhibited significant AAA depletion, whereas infants manipulated later did not exhibit depletion.

Recently it has been reported (*1*) that infant rats which had been manipulated (handled) once daily from birth responded to cold stress with a significant depletion of adrenal ascorbic acid as early as 12 days of age, whereas nonmanipulated infant rats did not show significant AAA depletion until 16 days of age. One question which arose from this study was whether the age at which the experimental treatment of manipulation was initiated is a significant factor in the accelerated maturation of the systems which result in AAA depletion with stress.

The experiment discussed in this report (*2*) was directed, therefore, toward answering the question of whether there exists a critical period in the development of the organism during which manipulation has its greatest effect on the AAA depletion response to stress. The existence of such a period seemed likely, since critical periods have been documented for many other aspects of development (*3*).

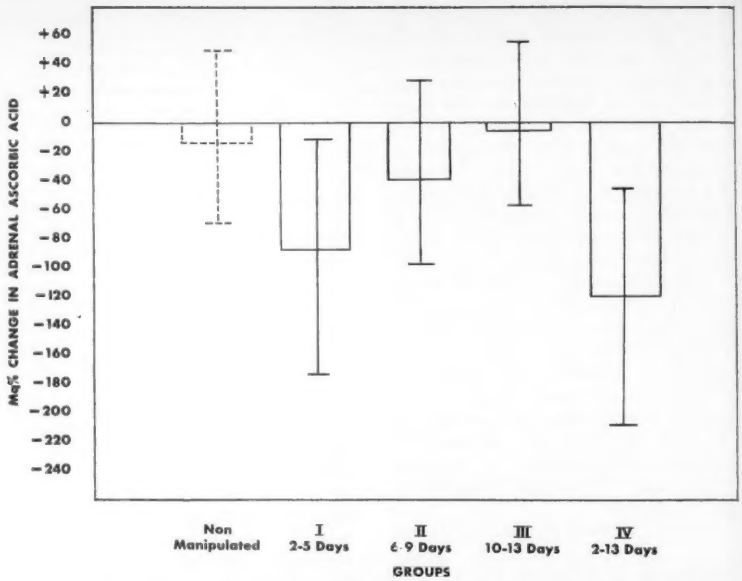

Fig. 1. Comparison of depletion in AAA in the various groups of infant albino rats of the study. The bar represents the mean depletion; the lines, the range. The dotted bar and dotted line represent untreated animals that had previously been tested.

Seventy-six infant Sprague-Dawley albino rats were used as subjects. The subjects were assigned at birth to one of four groups. For the infants in group I ($N = 20$), the treatment was initiated on the second day following birth and continued through day 5. The treatment was started on day 6 and was continued through day 9 for group II infants ($N = 20$). The treatment for the group III subjects ($N = 20$) was given from day 10 through day 13. The last group, group IV, received the treatment from day 2 through day 13. The experimental treatment was identical to that previously described (*1*) and consisted of removing the pup from the nest, placing it in a 2.5- by 3.5- by 6-in. compartment for 3 minutes, and then returning it to the nest. This procedure was followed once daily during the period assigned to the subject. At 14 days of age, approximately half the pups within each group were randomly assigned to either the stress or control condition to test for AAA depletion with stress.

The stress conditions and method of analysis for AAA are fully described in previous reports (*1*) and, therefore, will be only briefly described here. The nonstressed subjects within each group were killed by cervical spinal separation and weighed. The adrenals were removed, weighed, and assayed for AAA by the modified method of Glick *et al.* The stressed infants were subjected to a cold stress of 5°C for 90 minutes before removal of the adrenals and determination of AAA.

The results of this experiment are shown in Fig. 1 and are expressed in terms of milligrams percent change in AAA level. Change in AAA level was determined by subtracting the AAA present in the stressed animals from the mean for the nonstressed subjects.

The data clearly indicate that the age during which the infant rat is manipulated is a major variable in the effect described in this report. Only the animals in groups I and IV showed significant AAA depletion. In terms of percentage, the group I subjects showed a 25-percent depletion and the group IV subjects showed a 32-percent depletion. The depletion in AAA in the group II and group III animals (9 percent and 0 percent, respectively) did not differ significantly from that in the respective controls. Thus, in the groups (I and IV) which had been manipulated during the period directly following birth, a significant depletion in AAA is evidenced in response to cold stress at 14 days of age, whereas the groups manipulated later in infancy do not show significant AAA depletion.

Recent evidence has indicated that the early postnatal period is also critical for behavioral changes during adulthood.

Schaefer (*4*) found that handling during the first 7 days produced the greatest reduction in adult emotionality measured in terms of behavior in an open field situation. Denenberg (*5*) reports that handling during the first 10 days of life resulted in avoidance learning superior to that found when handling was initiated later. In both of these studies, the period during which the treatment was initiated includes the critical period found in the experiment discussed in this report. Whether behavioral difference can be detected in experiments with such restricted age groups as were tested in this experiment remains to be determined.

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31 July 1958

Nonidentity of Fetuin and Protein Growth (Flattening) Factor

Abstract. Fetuin, a fetal calf serum glycoprotein, appeared to possess activity with cultured mammalian cells similar to that of a protein growth factor partially purified from adult bovine and human sera. Column chromatography, however, yielded highly purified but inactive fetuin. These results leave open questions regarding the role of this interesting and readily purified protein.

Efforts to characterize the factors present in animal sera required for the growth of mammalian cells in culture led to the partial purification of a protein from bovine and human sera (*1*). The protein, studied most extensively with a culture of human origin, Appendix A 1 (*2*), causes adherence of cells to a glass surface; only in its presence do cells assume a flattened, epithelial-like appearance; and it is required for growth. Available evidence indicates that it is a glycoprotein.

Fisher, Puck, and Sato (*3*), working independently with a different cell culture, HeLa S3, reported some of these effects with fetuin, a glycoprotein from fetal calf serum. Their interesting results not only offered a rich source of the activity [fetuin represents about 45 percent of fetal serum protein (*4*)], but also suggested a possible in vivo growth-stimulating role for a molecule with flattening factor activity. The similar activity levels of fetal calf and beef sera, however, despite the high level of fetuin in the former, raised the question whether the activity of fetuin preparations might not result from contamination with the growth factor.

To test this possibility, highly purified fetuin was prepared. The protein was first precipitated from fetal calf serum with ammonium sulfate according to the initial step of the procedure of Fisher et al. (*3*). Electrophoretic analysis of this preparation showed that about 75 percent of the protein resided in a single peak whose mobility was the same as that of fetuin. After dialysis for 24 hours against sodium phosphate buffer (0.01*M*, *p*H 7.1), the ammonium sulfate fraction was applied to a column of DEAE-cellulose (type 20, height 10 cm, diameter 1.8 cm) according to the procedure of Sober *et al.* (*5*). Elution was carried out with sodium phosphate buffer solutions containing increasing concentrations of NaCl. Protein was estimated by the method of Lowry *et al.* (*6*); flattening factor activity was estimated by determination of the lowest concentration of each fraction which caused Appendix A 1 cells to adhere to a glass surface and induced the attached cells to assume an epithelioid shape (*1*).

The results of the fractionation procedure are illustrated in Table 1. As can be seen from Table 1, eluates 1 and 2 contained 74 percent of the recovered protein but only 6 percent of the recovered activity. On the other hand, most of the recovered activity appeared in eluate 4, which represented less than 12 percent of the protein.

To show that the inactive, peak-protein fractions contained fetuin, one of them (eluate 2) was examined ultracentrifugally and electrophoretically. As is shown in Fig. 1, ultracentrifugation yielded a single, symmetrical peak and the sedimentation constant ($Sw^{20} = 2.73$) was in good agreement with that of fetuin [$Sw^{20} = 2.60$ (*7*)]. In confirmation, electrophoretic analysis revealed a peak whose area was greater than 90 percent of the total area and which showed a mobility of -5.1×10^{-5} cm^2 v^{-1} sec^{-1} [under the same conditions (*8*), the mobility of fetuin in fetal serum was found to be -4.9×10^{-5}].

Ultracentrifugal examination of the active fraction, eluate 4, was complicated by its low protein concentration. However, two well-defined peaks were revealed. The major peak, representing about 80 percent of the total protein, was asymmetric and sedimented at a rate ($Sw^{20} \equiv 3$) similar to that of fetuin, while the minor component sedimented

Table 1. Chromatographic separation of fetuin and flattening factor. The eluents contained sodium phosphate buffer (0.025*M*, *p*H 7.1) except for eluate 4, which had instead 0.05*M* KH_2PO_4. In addition, the eluents contained 0.05, 0.075, 0.10, or 0.5*M* NaCl for eluates 1 to 4, respectively.

Fraction	Total protein (mg)	Total activity (unit)	Specific activity (unit/mg of protein)
Fetal serum	600	29,620	49.4
Ammonium sulfate	175	10,580	60.5
Pass through	1.0	0	0
Eluate 1	41.8	0	0
Eluate 2	85.0	250	2.9
Eluate 3	25.2	525	20.8
Eluate 4	19.8	3,390	171

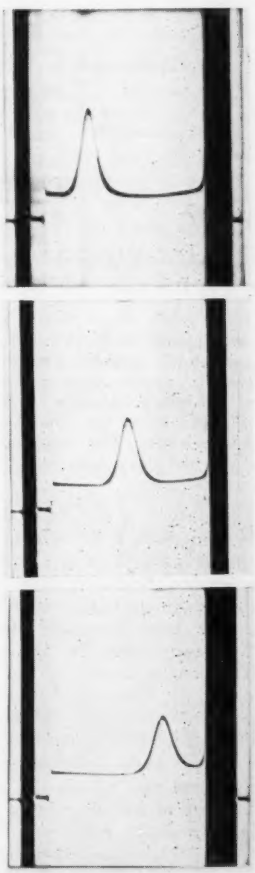

Fig. 1. Ultracentrifugal analysis of chromatographically purified fetuin. The protein, 10 mg/ml, was dissolved in sodium phosphate buffer (pH 7.1, $\Gamma/2 = 0.21$) and centrifuged at 59,780 rev/min. The photographs, from top to bottom, were taken 66, 126, and 186 minutes after maximum speed had been reached. The bar angle was 70 deg.

more rapidly. It was not determined which component contained the active protein.

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8. Electrophoretic analyses were made with sodium veronal buffer, pH 8.6, $\Gamma/2 = 0.1$. Mobilities were calculated from the patterns observed in the descending limb, and conductivity values were obtained by measurements on the protein solutions.
9. This investigation was supported by a research grant from the National Institutes of Health, U.S. Public Health Service.

29 August 1958

Sterility in Female Guinea Pigs Induced by Injection with Testis

Abstract. Adult virgin female guinea pigs were injected with an emulsion of homologous adult testis and Freund's adjuvant before exposure to males. The fertility of this group was only 24 percent while the fertility of the control group was 84 percent. The testis-injected guinea pigs had also a high titer of antibodies against testis.

The production of sterility in the female by immunizing her to sperm of the same species is a possible solution to excessive fertility. Beginning with Landsteiner's work, in 1899 (*1*), antibodies to sperm have been repeatedly demonstrated by complement fixation, sperm immobilization, agglutination, and anaphylaxis (*2, 3*). However, that sterility is induced by immunization of animals with the sperm of the same species is open to serious doubt. A number of observers reported some success, but further work in the field was discouraged by a thoroughly negative report of Henle *et al.* (*4*) in 1940, and since then the subject has been largely neglected. The introduction of Freund's adjuvant for enhancing immunization encouraged us to reinvestigate this approach (*5*).

Female guinea pigs (550 to 700 g) were given three successive intradermal injections 2 and 3 weeks apart. Injections totaled 0.7 ml, distributed in seven sites over the back. A cellular suspension in saline of fresh guinea-pig testis (240 mg per injection) was added to equal amounts of Freund's adjuvant to give a water-in-oil emulsion. Six animals received saline, 13 received Freund's adjuvant plus saline, and 13 received pooled testis plus Freund's adjuvant. Two guinea pigs from each group were bled and sacrificed 38, 61, and 78 days, respectively, after the last injection. No histological change was found in the ovary, uterus, kidney, vagina, or adrenal.

Seven weeks after the last injection, the rest of the animals (7 in the second and third groups) were exposed to a male for 3 weeks, then exposed to a second male for 3 weeks, and then isolated. Nine weeks after isolation the testis-injected guinea pigs were exposed to a male again for 4 weeks and to another male for 5 weeks and then isolated. Eight additional animals were similarly injected with material prepared from a single testis of their partner. The first injection was of freshly prepared material and the second and third injections were kept frozen (193 to 270 mg of testis per injection). Seven weeks after the last injection these animals were exposed to the donor of the testis for 6 weeks. Eight weeks after isolation from the male they were exposed to a second male for 6 weeks and then isolated.

As a second series, 52 guinea pigs (450 to 650 g) were used. Eight were not injected; 14 received Freund's adjuvant only; 14, Freund's adjuvant plus guinea-pig testis (300 mg per injection); 7, Freund's adjuvant plus guinea-pig liver (300 mg per injection); and 8, Freund's adjuvant plus Sherman rat testis (300 mg per injection). The animals were injected in the same manner as those in the first series; the animals in the second series were exposed to a male 7 weeks after the last injection. The male was changed every 3 weeks, and the females were observed for pregnancy for 15 weeks after exposure. Animals injected with guinea-pig testis showed high circulating antibody titers against guinea-pig testis. This was proved by tanned hemagglutination test (titer: control, < 20; experimental, 20 to > 5000); by agar gel diffusion test (three lines with testis saline extract); by sperm immobilization test (all sera and some vaginal fluid from immunized animals immobilized sperm within 5 minutes, even though control sera permitted sperm to live more than 60 minutes); and by positive skin reaction.

All animals were observed for ovarian function by means of vaginal smears from 5 weeks before the first injection until 7 weeks after the last injection. No animal showed ovarian dysfunction. In the first series, six of the seven controls injected with Freund's adjuvant were fertile. Only one of the seven immunized with pooled guinea-pig testis became pregnant, and two of eight given the partner's testis became pregnant. After isolation for 9 weeks, reexposure of the last two groups resulted in the same animals becoming pregnant; all others remained sterile.

Table 1. Summary of fertility in female guinea pigs.

Preparation	Number	Fertile
Controls		
No injection	8	7
Freund's adjuvant	7	6
Freund's adjuvant	14	11
Guinea-pig liver plus Freund's adjuvant	7	7
Rat testis plus Freund's adjuvant	8	6
Totals	44	37 (84%)
Study Animals		
Guinea-pig testis plus Freund's adjuvant	7	1
Guinea-pig testis plus Freund's adjuvant	8	2
Guinea-pig testis plus Freund's adjuvant	14	4
Totals	29	7 (24%)

In the second series, fertility was found in seven of eight noninjected controls; in 11 of 14 given Freund's adjuvant; in seven of seven given liver preparation; and in six of eight given rat-testis preparation. Only four of 14 given guinea-pig testis plus Freund's adjuvant became pregnant. Thus, fertility among the controls was 84 percent (37 of 44), while it was only 24 percent (7 of 29) in the group injected against homologous testis.

There are two possible mechanisms of sterility: (i) cellular immunity, as in Freund's experiment in aspermatogenesis (*3*), and (ii) circulating antibodies which could appear in the vaginal fluid according to our observation or which could cause the uterus to contract on contact with sperm, according to Katsh (*2*). But the mechanism of sterility is still uncertain, and it should be studied in the future.

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References and Notes

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5. This study was supported in part by funds from the National Institutes of Health, National Cancer Institute, Bethesda, Md. (grant No. C-3235).

23 July 1958

Letters

Research in Italy

The observations by David M. Gates on basic research in Europe (*1*) offer a sound basis for the further intensive analysis of comparative scientific institutions. His findings on research in Italy are strongly supported by observations of scholars in other fields. To a great extent, handicaps to research in sociology and anthropology are much the same as those reported by Gates (*2*).

Italy has made great strides in the development of the social sciences since the demise of Fascism. Neo-Hegelian idealism as fostered by the Croce school of historicism has hampered, if not hindered, the growth of empirical social sciences. Anthropology has, for the most part, been limited to a stilted pattern of growth. Narrow strictures have forced a continuation of physical anthropology in the mold of Lombroso. Aside from the anthropological offerings in medical schools, one finds "criminal anthropology" offered in the curricula of law faculties. In recent years, however, there has been a renewal of interest in cultural anthropology on the part of younger ethnologists. The Italian government, through the Ministry of Education, opened a Museum of Italian Ethnology in 1956, which is dedicated to the development of comparative ethnological studies (*3*). Of course, one should not ignore the research which has continued in archeology and ethnology under the direction of the Pigorini Museum and the Ministry of Education.

Within the realm of the social sciences generally, Italians are beginning to make excellent contributions to the development of logic, epistemology, and the philosophical basis of science (*4*). Despite the roadblocks established by the adherents of Croce, advances have been made in the post-World War II period. A problem similar to that noted by Gates besets sociology—a plethora of journals exists, some of them of questionable quality. Here, too, easy publication has fostered an emphasis on quantity. Yet we should not overlook the pressures on our side of the ocean to publish or perish.

In Italian anthropology and sociology the concept of teamwork has, until recently, been largely unknown. The work of the individual researcher has been uncoordinated and buried in obscure journals. As in the physical sciences, government-sponsored centers are attempting to coordinate and initiate research in needed areas. Inadequacies of library facilities hamper the work of the researcher (*5*). At this juncture it should be noted that American scientists can aid their Italian colleagues by donating needed books and journals to the libraries of the various university faculties in Italy.

Finally, a minor note of issue with Gates. Technically, the only degree granted by Italian universities is the *laurea,* which carries with it the title of *dottore* but is roughly equivalent to the American master's degree. The academic recognition which corresponds to the American Ph.D. is the *libera docenza,* obtained after rigid qualifications on publication have been met and after national noncompetitive examinations have been held by a committee of professors. Hence, Italy has an academic recognition rather than a degree which is equivalent to the Ph.D. (*6*).

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State of the Physical Sciences

In a recent review of *Matter, Earth, and Sky,* by George Gamow, the reviewer, W. P. Binnie, stated in his final paragraph that the reader will "find the author to be an illuminating writer on scientific matters as well as a provocative prophet" [*Science* **128**, 587 (1958)]. Binnie then quotes Gamow himself, as follows: "To sum up, we can say that the state of physical science today can be compared with the state of geography a few centuries ago: There are no Americas to be discovered any more."

It is astonishing to me that a physicist who has been acclaimed one of the foremost interpretative writers in the field of science today should have such a smug and short-sighted view concerning the likelihood of future discovery. There should be no question in the minds of scientists concerning the possibility that the well of new facts to be determined is drying up. With all the Americas discovered, we are now on the verge, thanks to physics, of discovering the universe, with its infinite numbers of geophysical Americas.

I would like to submit to Gamow and Binnie that not only will there always be Americas to be discovered but, further, that only he who has faith in their existence will be able to recognize them when he glimpses them from afar.

ROGER M. MORRELL
Montreal Neurological Institute, Montreal, Quebec

Gamow readily acknowledges that his opinion regarding the state of the physical sciences is strongly disputed by many of his colleagues, and he is well aware of the fate of similar predictions made by scientists from the time of Pierre de Laplace to Lord Kelvin. The premise upon which Gamow founds his prophesy is indeed a debatable one—namely, that the field of physical science is finite and that its laws, like geometrical theorems, are deductible from a set of axioms.

Nevertheless, Morrell is to be chided on two counts: first, for baselessly including me in Gamow's camp when I only bring an opinion to his attention; second, for failing to appreciate that former and similar predictions were negated not by revelations due to faith but rather by discoveries which Horace Walpole would have described as scientific serendipities.

Since Morrell is so easily moved to indignation, I hesitate to recommend, as a source of elaboration of this subject, Philippe le Corbeiller's "Crystals and the future of physics" [*Scientific American* (January 1953)], an essay that merited inclusion in *The World of Mathematics* (volume 2).

W. P. BINNIE

Purdue University, Lafayette, Indiana

Forthcoming Events

February

1–6. American Inst. of Electrical Engineers, winter general, New York, N.Y. (N. S. Hibshman, 33 W. 39 St., New York 18.)

2–6. American Soc. for Testing Materials (committee week), Pittsburgh, Pa. (ASTM, 1916 Race St., Philadelphia 3).

3–5. Reinforced Plastics Conf., 14th, Chicago, Ill. (Soc. of Plastics Industry, Inc., 250 Park Ave., New York 17.)

6–7. American College of Radiology, Chicago, Ill. (W. C. Stronach, 20 N. Wacker Dr., Chicago 6.)

7–8. Chemistry of Coordination Compounds, symp., Allahabad, India. (A. K. Dey, Chemistry Dept., Univ. of Allahabad, Allahabad, India.)

9–11. American Acad. of Allergy, Chicago, Ill. (B. Rose, Royal Victoria Hospital, Montreal, P.Q., Canada.)

9–11. Nature of Coal, symp., Bihar, India. (Director, Central Fuel Research Inst., P. O. Fuel Research Inst., Dhanbad District, Bihar.)

9–24. Pneumoconiosis, intern. conf., Johannesburg, South Africa. (S.A.C.S.I.R., 18 London House, Loveday St., Johannesburg, S.A.)

11–13. American Acad. of Occupational Medicine, Boston, Mass. (L. Blaney, 1608 Walnut St., Philadelphia, Pa.)

12–13. Solid State Circuits Conf., Philadelphia, Pa. (A. B. Stern, General Electric Co., Bldg. 3, Syracuse, N.Y.)

14. Short Range Navigation Aids., Montreal, Canada. (Intern. Civil Aviation Organization, Maison de l'Aviation Internationale, Montreal.)

14–21. Planned Parenthood, 6th intern. conf., New Delhi, India. (Secretary, 1 Metropolitan House, Dadabhari, Naoroji Rd., Bombay 1, India.)

15–19. American Inst. of Mining, Metallurgical, and Petroleum Engineers, annual, San Francisco, Calif. (E. O. Kirkendall, AIME, 29 W. 39 St., New York 18.)

16–19. Problems in Field Studies in Mental Disorders, intern. work conf., New York, N.Y. (J. Zubin, American Psychopathological Assoc., 722 W. 168 St., New York 32.)

20–21. Epidemiology in Mental Disorders, annual meeting of the American Psychopathological Assoc., New York, N.Y. (J. Zubin, APA, 722 W. 168 St., New York 32.)

23–27. American Concrete Inst., 55th annual, Los Angeles, Calif. (W. A. Maples, A.C.I., 18263 W. McNichols Rd., Detroit 19, Mich.)

25–26. Midwest Industrial Radioisotopes Conf., Manhattan, Kan. (J. Kitchens, Dept. of Continuing Education, Kansas State College, Manhattan.)

25–27. Biophysical Soc., annual, Pittsburgh, Pa. (G. Felsenfeld, Dept. of Biophysics, Univ. of Pittsburgh, 325 Clapp Hall, Pittsburgh 13.)

26–28. American Acad. of Forensic Sciences, annual, Chicago, Ill. (W. J. R.

Camp, AAFS, 1853 W. Polk St., Chicago 12.)

26–28. Genetics and Cancer, 13th annual symp. on fundamental cancer research, Houston, Tex. (Editorial Office, Univ. of Texas, M. D. Anderson Hospital and Tumor Inst., Texas Medical Center, Houston 25.)

27–1. National Wildlife Federation, 23rd annual convention, New York, N.Y. (NWF, 232 Carroll St., NW, Washington 12.)

March

1–2. Pennsylvania Acad. of Sciences, Gettysburg. (K. Dearolf, Public Museum and Art Gallery, Reading, Pa.)

1–5. Gas Turbine Power Conf., Cincinnati, Ohio. (O. B. Schier, ASME, 29 W. 39 St., New York, N.Y.)

8–9. American Broncho-Esophagological Assoc., Hot Springs, Va. (F. J. Putney, 1712 Locust St., Philadelphia, Pa.)

8–9. American Laryngological Assoc., Hot Springs, Va. (J. H. Maxwell, University Hospital, Ann Arbor, Mich.)

8–12. Aviation Conf., Los Angeles, Calif. (O. B. Schier, ASME, 29 W. 39 St., New York, N.Y.)

10–12. American Laryngological, Rhinological and Otological Soc., Hot Springs, Va. (C. S. Nash, 708 Medical Arts Bldg., Rochester 7, N.Y.)

13–14. American Otological Soc., Hot Springs, Va. (L. R. Boies, University Hospital, Minneapolis 14, Minn.)

13–15. Alabama Acad. of Sciences, Auburn. (H. M. Kaylor, Dept. of Physics, Birmingham-Southern College, Birmingham, Ala.)

15–20. American College of Allergists, San Francisco, Calif. (M. C. Harris, 450 Sutter St., San Francisco.)

16–19. American Assoc. of Petroleum Geologists, Soc. of Economic Paleontologists and Mineralogists, 44th annual, Dallas, Tex. (W. A. Waldschmidt, AAPG, 311 Leggett Building, Midland, Tex.)

16–20. American Inst. of Chemical Engineers, Atlantic City, N.J. (F. J. Van Antwerpen, AICE, 25 W. 45 St., New York 36.)

16–20. National Assoc. of Corrosion Engineers, 15th annual conf., Chicago, Ill. (NACE, Southern Standard Bldg., Houston, Tex.)

16–20. Western Metal Exposition and Cong., 11th, Los Angeles, Calif. (R. T. Bayless, 7301 Euclid Ave., Cleveland 3, Ohio)

17–19. National Health Council, Chicago, Ill. (P. E. Ryan, 1790 Broadway, New York, 19.)

18–25. International Social Science Council, 4th general assembly (by invitation), Paris, France. (C. Levi-Strauss, Secretary-General, International Social Science Council, 19, avenue Kleber, Paris.)

19–21. Society for Research in Child Development, NIH, Bethesda, Md. (Miss N. Bayley, Laboratory of Psychology, National Inst. of Mental Health, Bethesda 14, Md.)

23–26. Institute of Radio Engineers, natl. conv., New York, N.Y. (G. L. Haller, IRE, 1 E. 79 St., New York 21.)

24–27. American Meteorological Soc., general, Chicago, Ill. (K. C. Spengler, AMS, 3 Joy Street, Boston, Mass.)

27–28. Michigan Acad. of Sciences, East Lansing. (D. A. Rings, Univ. of Michigan, Dept. of Engineering, Ann Arbor.)

28. South Carolina Acad. of Sciences, Columbia. (H. W. Freeman, Dept. of Biology, Winthrop College, Rock Hill, S.C.)

29–3. Latin American Congress of Chemistry, 7th, Mexico D.F., Mexico. (R. I. Frisbie, Calle Ciprès No. 176, Zone 4, Mexico, D.F.)

30–1. American Orthopsychiatric Assoc., San Francisco, Calif. (M. F. Langer, 1790 Broadway, New York 19.)

30–12. Bahamas Medical Conf., 7th, Nassau. (B. L. Frank, 1290 Pine Ave., W. Montreal, Canada.)

31–2. American Power Conf., 21st annual, Chicago, Ill. (N. S. Hibshman, AIEE, 33 W. 39 St., New York 18.)

31–2. Symposium on Millimeter Waves, 9th, New York, N.Y. (H. J. Carlin, Microwave Research Inst., 55 Johnson St., Brooklyn 1, N.Y.)

31–5. International Committee of Military Medicine and Pharmacy, 21st session, Paris, France. (Comité International de Médecine et de Pharmacie Militaires, Hôpital Militaire, 79, rue Saint Laurent, Liège, Belgium.)

April

1–3. American Assoc. of Anatomists, Seattle, Wash. (B. Flexner, Univ. of Pennsylvania Medical School, Philadelphia 4, Pa.)

1–4. National Council of Teachers of Mathematics, Dallas, Tex. (H. T. Karnes, Dept. of Mathematics, Louisiana State Univ., Baton Rogue 3.)

1–4. National Science Teachers Assoc., 7th natl. conv., Atlantic City, N.J. (R. H. Carlton, NSTA, 1201 16 St., NW, Washington 6.)

1–4. Neurosurgical Soc. of America, Hot Springs, Va. (F. P. Smith, 260 Crittenden Blvd., Rochester 20, N.Y.)

1–29. World Meteorological Organization, 3rd session of congress, Geneva, Switzerland. (WMO, Campagne Rigot, 1, avenue de la Paix, Geneva.)

2–4. Association of American Geographers, 55th annual, Pittsburgh, Pa. (J. E. Guernsey, 9707 Parkwood Dr., Bethesda, Md.)

2–4. Association for Computing Machinery, Cleveland, Ohio. (J. Moshman, Corporation for Economic and Industrial Research, 1200 Jefferson Davis Highway, Arlington 2, Va.)

2–4. Optical Soc. of America, New York, N.Y. (S. S. Ballard, Scripps Institution of Oceanography, Univ. of California, San Diego 52.)

3–4. Eastern Psychological Assoc., Atlantic City, N.J. (C. H. Rush, Standard Oil Co. of New Jersey, Rockefeller Plaza, New York, N.Y.)

3–5. American Soc. for the Study of Sterility, Atlantic City, N.J. (H. H. Thomas, 920 S. 19 St., Birmington 5, Ala.)

3–5. Cooper Ornithological Soc., Berkeley, Calif. (J. Davis, Univ. of California, Hastings Reservation, Jamesburg Route, Carmel Valley.)

(See issue of 19 December for comprehensive list)

Equipment

The information reported here is obtained from manufacturers and from other sources considered to be reliable. Science *does not assume responsibility for the accuracy of the information. A coupon for use in making inquiries concerning the items listed appears on page 54.*

■ ROLLER-TUBE APPARATUS for growing tissue cultures or viruses comprises a base-mounted motor driving a three-plate aluminum drum for rotating the culture tubes. A model with a drum 14 in. in diameter accommodates 164 tubes 16 mm or smaller. Over-all dimensions of this model are 16½ by 14 by 10½ in. Rotation rate is 1/5 rev/min. (New Brunswick Scientific Co., Dept. 549)

■ AIR SAMPLER operates from a 6-v battery to collect samples of dusts and radioactive aerosols. Air is sampled at a rate of 1 ft^3/min through a high-efficiency filter. Flow rate is indicated by a flowmeter that is part of the sampler. (Gelman Instrument Co., Dept. 550)

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■ MODULATION METER measures percentage modulation of either a voltage or a frequency. A switch selects either function. The instrument is designed for a basic carrier of 400 cy/sec and has a modulation range 0 to 2 percent. Accuracy is ±5 percent of full scale, corresponding to 0.1 percent modulation. Modulation frequency response is 1 to 75 cy/sec. Cross-product effects are small. Other carrier frequencies can be provided. (Voltron Products, Dept. 557)

■ ULTRAVIOLET MICROSCOPE ILLUMINATOR provides radiation in the range 3600 to 4000 A, with high intensity at 3650 to 3660 A. The source uses a General Electric sealed-beam, reflector-type, high-pressure mercury spotlight. A filter removes more than 90 percent of the visible light. The illuminator is provided with a transformer and is mounted on the microscope. (Burton Manufacturing Co., Dept. 559)

■ INFRARED SPECTROPHOTOMETER uses a potassium bromide prism for dispersion to cover the 12.5- to 25-μ region. The instrument incorporates design and operating features of previous models with

NaCl prisms except for new wavelength and slit cams and a new monochromator window that serves also as a scattered-light filter. Scanning time is 6.5 min. Abscissa accuracy is ±1 percent. Scattered light is less than 5 percent at 24.5 μ, decreasing to less than 1 percent for shorter wavelengths. (Perkin-Elmer Corporation, Dept. 561)

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■ TEFLON DISPERSIONS for coating application can be cured at temperature of 300°F or less. The dispersion is mixed with a binder for application with a spray gun. A dispersion in a phenolic binder cures in 1 hour at 300°F. An air-drying dispersion is available for more heat-sensitive substrates. (Acheson Colloids Co., Dept. 565)

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■ SAMPLING SWITCH is comprised of three poles with 30 contacts per pole operating at 5 rev/sec. Two of the poles are designed to scan differential-thermocouple and strain-gage signals, while the third pole provides the timing function. Noise levels are in the order of 20 to 30 μv throughout the 1000-hr operating life. (Instrument Development Laboratories, Dept. 574)

JOSHUA STERN
National Bureau of Standards

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Equipment Technician. Background in any area of natural science; 2 years experience in design and construction of laboratory equipment and materials for instructional purposes; B.S. degree preferred. Ability to supervise and train technical nonteaching employees; small college town in northern California; salary: $4980–6060. Inquiries should be made to Staff Personnel, Chico State College, Chico, California. X

Microbiologist-Antibiotics. Eastern pharmaceutical firm has opening for able Ph.D. with laboratory fermentation experience in antibiotic field. Please send résumé of academic training and experience. Box 251, SCIENCE. 12/26; 1/2

(a) **Pharmaceutical Development Manager**; preferably Ph.D. or equivalent, pharmaceutical chemistry; 10 years' experience responsible level pharmaceutical industry; thorough knowledge pharmaceutical formulation, new products, market potential, pharmaceutical products in South America and other major markets; frequent travel abroad; $12,000–$15,000; knowledge of Spanish required; East. (b) **Research Bacteriologist**; experienced tissue culture; research concerned, antibiotics, other products; Ph.D., will consider M.S., good experience; teaching institution, Midwest. (c) **Biochemist**, Ph.D.; direct laboratory, staff 30 to 35; one well qualified technically with administrative capabilities; 380-bed hospital; California; $10,000. (d) **Biochemist**, Ph.D. or M.S., trained newest techniques for steroid assays; direct endocrine laboratory, state college, winter resort town, South; $5000–$7000. S-1-Medical Bureau, Burneice Larson, Director, 900 North Michigan, Chicago. X

Ph.D. or equivalent, recent, for research in biology, pharmacology; eastern industrial organization; $6000–$8000; advancement possible for man with initiative and imagination. Box 3, SCIENCE. X

Postdoctoral Traineeship in Neuropharmacology Available for the Ph.D. in chemistry, biochemistry or pharmacology or the M.D. who would like to broaden his training and enter research in neuropharmacology. Stipends from $4500 per year and up plus dependent allowance. Postdoctoral fellowships in other areas, such as biochemical pharmacology, antibiotics, energy and drug enzymology, are also available. Write Chairman, Department of Pharmacology, Washington University School of Medicine, St. Louis 10, Missouri. 1/9, 16, 23, 30, 2/6

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FELLOWSHIPS

Research Fellowships in biochemical pharmacology are available for qualified individuals to study for Ph.D. degrees. A background in chemistry is desirable. Stipends begin at $1800 per year, plus dependent allowance. Write Chairman, Department of Pharmacology, Washington University School of Medicine, St. Louis 10, Missouri. 1/9, 16, 23, 30; 2/6

SCHOLARSHIPS

McMASTER UNIVERSITY GRADUATE SCHOLARSHIPS IN BIOLOGY

Applications are invited for graduate research scholarships from qualified students wishing to work toward the M.Sc. and Ph.D. degrees. The stipend for a 12-month period is from $1700 to $2200. Research in progress: Ecology, behavior, and nutritional physiology of aquatic and blood-sucking Diptera, emphasizing Simuliids; population dynamics of grasshoppers (D. M. Davies). Sensory physiology and behavior in fish; formation of lake bottom sediments (H. Kleerekoper). Viruses in wild plants; cytological studies (W. D. MacClement). Physiology of sporulation in Ascomycetes; physiology and genetics of yeast (J. J. Miller). Radiobiology and radiation protection; inhalation radiocardiography; cancer transplantation and irradiation; experimental diabetes and beta-cell regeneration; tritium autoradiography (P. F. Nace). Experimental embryogeny; organic terrain organization; palaeobotany and developmental morphology; applied palaeobotany and palynology (N. W. Radforth).

Prospective applicants should write for further information to Professor H. Kleerekoper, Chairman, Department of Biology, Hamilton College, McMaster University, Hamilton, Ontario, Canada. Application forms both for scholarships and graduate study are obtainable from the Dean of Graduate Studies and must be returned to him normally by 1 March 1959, accompanied by university transcript and letters of recommendation from two professors. 12/26; 1/2

POSITIONS OPEN

Ph.D., Biochemistry, recent graduate, to supervise group of technicians for routine and research. Southern California location. Box 256, SCIENCE. 1/16

(a) **Psychologist**; coordinator, vocational services; challenging position, excellent potential; to $8000, yearly increases; large city, East. (b) **Bacteriologist**; county health laboratory, modern, well equipped; $5300, overtime; state civil service benefits; eastern resort community 20,000. (c) **Chemist**; M.S., Ph.D. experienced hormone analysis, toxicology, chromatography; excellent opportunity to head department, well-established California research, testing laboratories; to $10,000. (d) **Chief Chemist**; Ph.D., 2 to 3 years of clinical experience; head laboratory section, large new cancer research hospital; to $12,500; East. (e) **Bacteriologist**; M.S., Ph.D. to head department, 300-bed general hospital; superior laboratory facilities; $7500–$8000; western resort, university city. Woodward Medical Bureau, Ann Woodward, Director, 185 North Wabash, Chicago. X

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Ph.D., Experienced in Clinical Chemistry, to supervise group of analytical technicians. Salary $10,000 or more, depending on experience. Southern California location. Box 255, SCIENCE. 1/16

Research and Teaching Assistantships available: Department of Physiology and Biochemistry, College of Arts and Sciences, Rutgers, the State University, New Brunswick, New Jersey. Thesis may be in protein nutrition, tissue culture and inorganic metabolism, or enzymes. Please write chairman of the department.

2 January 1959

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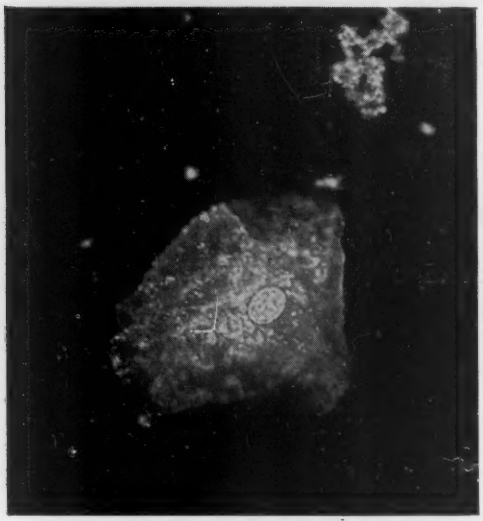
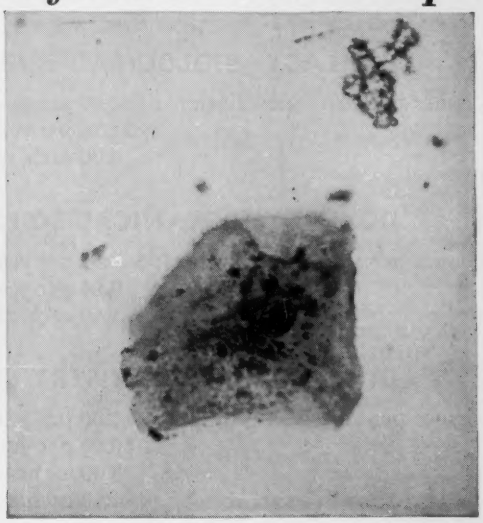
with the AO-Baker Interference Microscope



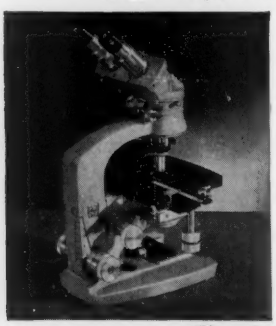
1. First, as shown in the photomicrograph* above, the microscope analyzer was rotated until the background was brought to extinction. Readings were taken directly from the analyzer scale. Averaged settings resulted in reading of 70.4°.



2. Next, the analyzer was rotated until the nucleus of the cell was brought to extinction. Averaged settings resulted in reading of 138.2°.

3. The Optical Path Difference, in degrees, is *twice* the difference between the two readings:

$$OPD = 2\,(138.2° - 70.4°) = 135.6°, \text{ or } OPD = \left(\frac{135.6°}{360°}\right).546 = .206 \text{ Microns.}$$



Optical path difference measurements can be made to an optimum accuracy of 1/300 wavelength. This unique ability to measure optical path thicknesses is in itself of great importance. But even more important, these measurements can be converted into a variety of quantitative information of great potential value. Water and protein content of a cell, for example, may be measured. Materials such as glass, plastics, emulsions, textiles can be examined.

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*Photomicrographs taken by Mr. Lynn C. Wall, Medical Division, Eastman Kodak Co. Data: Epithelial Cell. AO-Baker Interference Microscope, 40X Shearing objective, 10X eyepieces. Corning filter CS4-120 with AO Model 630 Pulsarc Illuminator to transmit monochromatic light at .546 microns.

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